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# USSR Report

EARTH SCIENCES

No. 14

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11 May 1981

USSR REPORT  
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## METEOROLOGY

### CLIMATIC CHANGES AND MANKIND'S STRATEGY

Moscow ZEMLYA I VSELENNAYA in Russian No 1, Jan-Feb 81 pp 11-13

FEDOROV, Ye. K., academician

[Abstract] The article gives a broad-brush review of natural and anthropogenic changes in climate, such subjects as the following being considered: warming of the Arctic, transformations of structure of the planetary surface, transformation of the moisture cycle, purposeful modification of climate, transformation of the planetary energy balance, changes in atmospheric transparency and intervention in the dynamics of the ocean and the atmosphere. It is clear that some strategy must be formulated, that is, there is a need for a system of preplanned long-range measures, which will enable mankind to escape the negative consequences of changes in climate. This program must be on a regional and global, not local scale. The first and most important component of this program is prediction of climatic changes. This is a highly complex problem requiring the creation of a quantitative physical theory of climate and methods for calculating its changes under the influence of different effects. There is complete confidence that this problem will be solved, although it will require considerable time and strong international co-operation. A second element of the strategy is an evaluation of the consequences which will follow from different natural or anthropogenic changes in climate. The scientific problem here is closely intertwined with socioeconomic factors. The third aspect of the strategy is the formulation of recommendations on those measures which would make it possible to avoid the negative consequences of climatic changes or avoid its changes. Such recommendations are even now being proposed. They include a sharp reduction in the use of fuel so that there will be no further increase in the content of atmospheric carbon dioxide. Measures should be taken for increasing the absorption of carbon dioxide by the biosphere. The production and consumption of energy must be limited in order to maintain the heat balance of the planet. Scientists are warning strongly that if such recommendations are not followed mankind will have to contend with dangerous climatic changes in the next 50-100 years. For the most part the recommendations are directed to the maintenance of the present climate, although it has been suggested that the climate can be improved.

[71-5303]

## BRIEFS

**NEW PREPARATION FOR CLOUD SEEDING**—The picture was taken when chemists, in collaboration with meteorologists, tested the effects of a new crystalline reagent: 20 grams of preparation dispersed from an airplane into the clouds. A space in the clouds with an area of almost 1,500 hectares was formed. Approximately 80 tons of water fell as rain for every gram of expended reagent. The preparation is easy to prepare and discharge, is harmless for the surrounding atmosphere and costs less than silver iodide, which is normally used for such purposes. It is becoming possible to create atmospheric precipitation as desired and regularly accumulate moisture in the ground or snow in the fields. The new crystalline reagent for the artificial creation of atmospheric precipitation is only one of the many examples of the practical application of the results of fundamental and practical investigations conducted at the Institute of Physical Chemistry imeni L. V. Pisarshevskiy in the division which is managed by the UkSSR State Prize Laureate and UkSSR Academy of Sciences Corresponding Member A. A. Chuyko. [Kiev PRAVDA UKRAINY in Russian 28 Jan 81 p 4]

[101-P]



## OCEANOGRAPHY

### DEVELOPMENT OF NEW OCEAN RESEARCH APPARATUS

Moscow IZVESTIYA in Russian 12 Mar 81 p 6

[Excerpts] Specialists of the All-Union Scientific Research Institute for the Fishing Industry and Oceanography (VNIRO) and the Central Design-Construction Technological Bureau of the All-Union Fishing-Industry Association of the Western Basin are working on the new "OKA" complex for oceanographic investigations. The basic units of the apparatus have proven themselves in the course of recent experiments.

"The oceanographic complex apparatus (abbreviated 'OKA') will be able to conduct investigations with great accuracy," states the head of the VNIRO laboratory, Candidate of Geological-Mineralogical Sciences P. Yerofeyev. The task is as follows: to produce devices which are easily combined into a single complex but at the same time, devices which can function independently. The 'OKA' is intended for the automated collection and primary processing of information. The basic element of the complex is the automated cassette bathometer 'Dionon,' a device for the taking of water samples and temperature, salinity and depth measurements. It can gather valuable data about the structure and condition of very thin layers of sea water, and most importantly, explain the essence of the bottom layer, which is not easily accessible. Until now there has been no accurate way to do this. The collected data will be processed with the help of electrical devices. The first experimental group of bathometers will soon find application aboard industrial prospecting ships."

With time the new complex will become what is called a "jack of all trades." It will provide information about the basic hydrooptical characteristics of sea water, information on the oxygen content of the water and plankton concentration. The direction and speed of currents is the task of still another of the devices, the "Vikr" measuring instrument.

Work on perfecting of the "OKA" complex is continuing. It will be able to resolve many scientific and industrial problems.

[114-P]

## R-10 COMPUTER AS PART OF MARS SYSTEM ON OCEANOGRAPHIC VESSEL

Budapest INFORMACIO ELEKTRONIKA in Hungarian No 1, 1981 pp 31-35

[Article by Ivan Fedorovich Glumov, director of the Yuzhmorgeologia Research Institute, Janos Kassmer, director of the Videoton Computer Technology Factory, and Dr Pal Muller, director of the Lorand Eotvos Geophysical Institute: "Navigational-Geophysical Ocean Research Systems Based on an R-10 Computer"]

[Text] Ocean research is a special, quickly developing area of minicomputer application. The article describes the successful utilisation of Hungarian hardware on geophysical ocean research ships. R-10 computer centers organize the navigational-geophysical data collection and processing functions of the MARS system, developed through Soviet-Hungarian cooperation; the computer centers were supplemented with special units and provided with the necessary software for this purpose. The article also turns to further possibilities of the next VT generation, the R-11. (Arrived: 16 May 1980.)

### Requirements and Automation Tasks of Modern Ocean Research

The importance of seas and oceans in ensuring raw material resources for mankind is increasing very quickly. Already the continental shelves provide one quarter of our most important energy source, oil. Instrumented ocean research has taken on powerful proportions, one third of the sum spent on geophysical research is spent here. The extraordinarily high costs made it timely to construct special research vessels with which a whole series of geophysical operations can be carried out at one time. This makes it possible to decrease the time needed for research and to study from many sides the geological structure under the sea. Geophysical data—primarily in the case of seismic methods based on the creation of elastic waves—provide a great deal of information (at a speed of 32-96 Kbytes per second), changing quickly in time, which, according to the unwritten rules of modern digital technology, must be recorded on magnetic tape. The large geophysical computer centers are on dry land far from the areas of ocean research. Long months elapse between recording and processing. This deprives the on-board geophysicists of the possibility of judging the geological value of primary information and quickly optimizing the recording methods and parameters.

A solution to the problem was obvious—a computer center had to be installed on the ship with which data could be processed en route, displaying the geophysical profiles, after the study of which the recording parameters could be optimized.

This simple formulation of the task does not suggest those difficulties which a computer technology expert faces on a geophysical research vessel. Here are a few examples:

- Real-time handling and processing of the seismic data from a volume of seismograms requires a very fast computer and divided memory allocation (DMA).
- The computer center must be shock proof so that it is capable of functioning even with an oscillation of 5-6 bal when at sea.
- Modern navigation, the precision requirements of getting fixes, makes it necessary to use artificial satellites and Doppler instruments, which also require a fast computer.
- Complex research requires simultaneous data processing for several geophysical methods (seismic, gravitational, magnetic).
- Ships prospecting for raw materials are of small size so the computerized instrument complex must fit into a small cabin space.

Development of on-board real-time pre-processing systems is an expensive, complex task which it is useful to tie in with the solution of other important technological, instrumentation and navigation problems of ocean geophysical research. In the final analysis every effort should be directed at increasing the geological efficiency of ocean research. The most important timely tasks in this are the following:

- improving the resolution of surveys and the reliability of geological structural information;
- improving productivity and the quality of oceanic geophysical data, increasing the number of channels and decreasing noise;
- automation of the recording process, real-time display and checking of geophysical profiles; and
- exploiting new research procedures which can be achieved by the introduction of computer technology.

#### Selecting and Modifying On-Board Computers for Ocean Research

Taking into consideration and making use of every viewpoint raised in the course of analysis one can increase the efficiency of ocean research only with the aid of a completely automated, computerized on-board data collection and data processing system. A key question was the selection of a suitable computer, of a size to fit into the narrow space on board but which also met the requirements on the basis of its speed and peripheral selection. Of the equipment of socialist manufacture available to us the R-10 computer of Videoton proved most suitable for this purpose. The speed and size of the computer and, not least of all, the fact that its peripherals could be well modified for navigational purposes justified

the choice. It was possible to make the fixed head disk memories and line printers suitable for reliable operation even with ship inclines and shocks corresponding to an oscillation of 6-7 bal.

### The Complex Geophysical-Navigational MARS System

After selecting the base computer we could begin, in 1976, to create the so-called MARS system within the framework of the "Intermorgeo" program as part of Soviet-Hungarian OMFB [National Technical Development Committee] and GKNT [expansion unknown] cooperation. (The Hungarian institutions participating in the program are Videoton, the ELGI [Lorand Eotvos Geophysical Institute], the MOM [Hungarian Optical Works], the SZAMKI [Computer Technology Research Institute], and the OKGT [National Oil and Gas Industry Trust]. From the Soviet side they are: the NPO Yuzhmorgeo, the PO Yuzhmorgeologia and the OKB VT RRTI.) The developmental work was successful. Several ships have been equipped with the system already, including the Issledovatel, the Kurentsov and the Feodosia, which are doing complex geophysical research at sea.

In the hierarchy of automated navigational-geophysical on-board systems the MARS system represents a higher order step since in addition to data collection and delayed pre-processing it also does real-time geophysical express data processing. The developmental program for the MARS-2 version includes the construction of a special geophysical ship, integrated navigation equipment, a real-time seismic system, gravi-magnetic units and R-10 computer centers and the development of special geophysical peripherals and of geophysical and navigational software.

MARS is built in a modular system so further expansion and adaptation in accordance with the requirements of oceanic geophysical work is possible (Figure 1). The free channels of the DMA multiplexer serve the same purpose.

The navigational system is also built on the R-10 computer. The fact that the computers operating on the vessel are of the same type facilitates service and parts supply. The integrated navigational system contains digital receiving indicators for the radio navigation and radio geodesy network, a sputnik receiving indicator, a Doppler speedometer, a normal speedometer, a gyrocompass, and a gyro-rudder. The program system ensures control over the collection of all navigational data and optimized processing thereof with the use of the algorithms of Kalman filters for the purpose of calculating the parameters of ship movement and recording them on magnetic tape. On the basis of information received from artificial satellites passing over the ship the computer immediately determines the coordinates and, taking into consideration also the meteorological data, the guidance of the ship is completely automatic, according to the program provided. The on-board seismic system also gets control signals from navigation in accordance with the cycle times of the selected observation parameters. Modern navigation makes possible three-shift observations even on distant oceans.

### The Gravitation and Magnetic Instruments

Since the load on the seismic center is substantially greater the collection and processing of gravitational and magnetic data is shifted to the navigational computer. The on-board gravitation instrument unit consists of GAK-253 gravimeters



and a gyro-stabilized platform mounted in parallel. The combined closure precision in determining gravitational anomalies is plus or minus one mgal after a 2-3 day measurement series. The gravitation measurement data go through an interface directly into the navigation computer where they are immediately processed, taking into consideration the new navigation data, and the results are then displayed graphically or printed out.

The on-board magnetic instruments are, on the one hand, quantum gradient measuring magnetometers (KMG-1) and, on the other hand, oceanic proton precession magnetometers (PM-2). The probe of the proton instrument is placed in a suspended gondola, its measurement domain embraces the entire breadth; the registering stage is on board. The gradient meter measures the magnetic field with a precision of plus or minus 0.02 gamma. The path for collecting and processing magnetic data is similar to that for gravitational data.

#### The On-Board Seismic Center

The task of the on-board geophysical center is to handle and perform real-time pre-processing on a mass of seismic data flowing in with great speed, in the 10-24 second pauses between shocks. This task can be carried out only with suitable memory allocation and automatic control of key peripherals because the mass of data, exceeding the capacity of the operational memory, must be sent on with great speed while the central processor carries out other tasks. For this reason the R-10 computer is supplied with a DMA, the 8-channel multiplexer of which connects with the following units, in order of their priority:

- disk memory,
- seismic receiving instrument,
- magnetic tape data carrier,
- special array processor.

The free DMA channels offer further possibilities for connecting more processors into the hierarchic system, for example to do speed analysis or to connect new adapters.

From the viewpoint of computer technology the special (or array) processor merits special attention, which for the first time in Hungary has been connected organically into the configuration of a computer family. The special processor solves the speed defect for real-time seismic processing. Certain filtering and processing operations in ocean research (for example, the convolution integral) require a speed greater by an order of magnitude than the speed of the R-10. The special processor uses the basic processor of the computer only for the time needed to pass on the data, otherwise it carries out its operations in its own fast 16 Kword semiconductor operational storage, but there is also a possibility for floating decimal storage of the results of partial operations up to 1 Kwords. The cycle time for one multiplication and addition is 250 ns. In addition to traditional mathematical operations it also performs several geophysical operations electronically, directly with hardware.

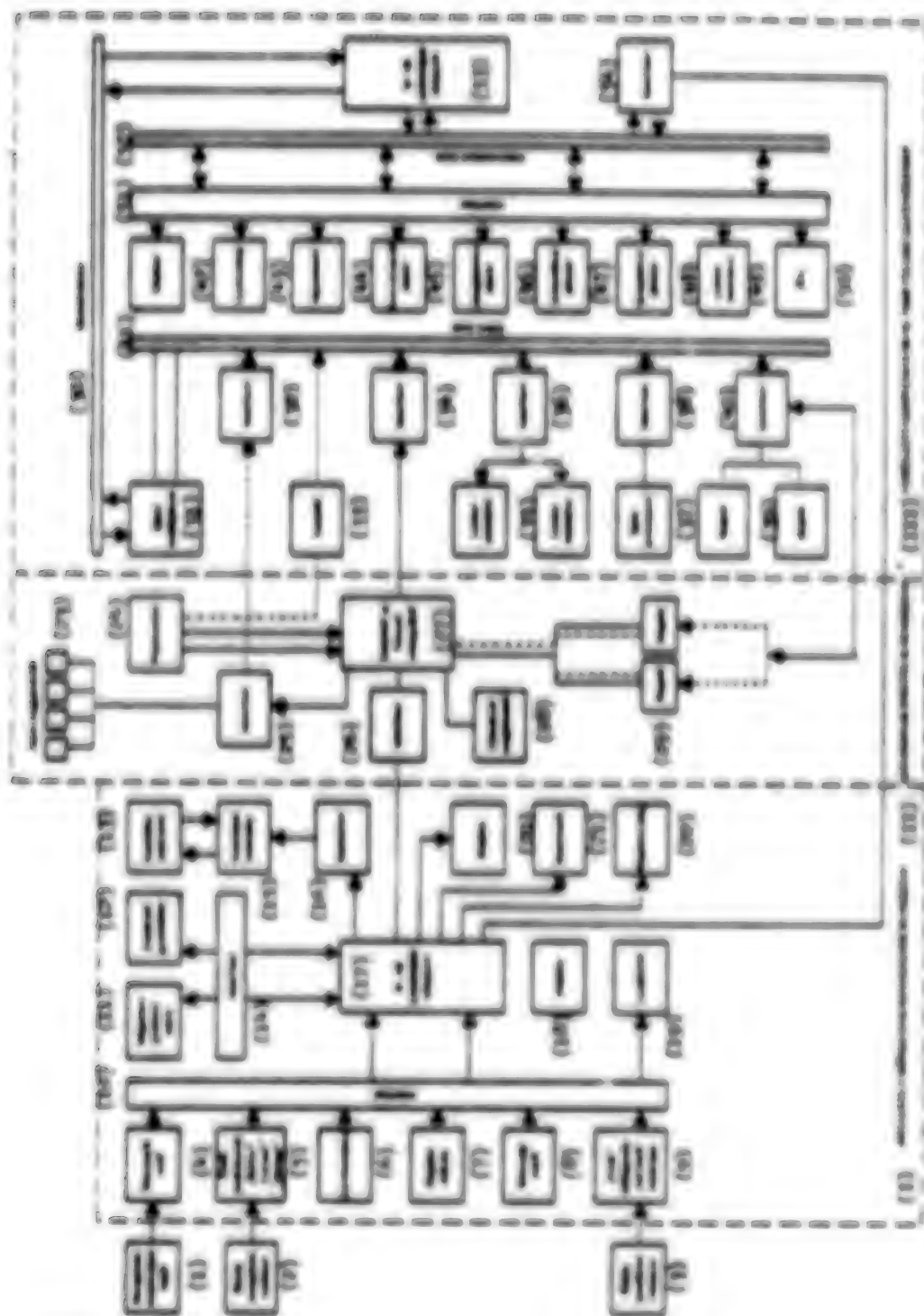


Figure 1. Block diagram of the NAB real-time on-board geophysical pre-processing center.

[Key on following page]

# Key:

- |  |                                      |
|--|--------------------------------------|
| I. Integrated artificial satellite navigation system.  | 25. Interface                        |
| II. Seismic digital system.                            | 26. Interface                        |
| III. On-board geophysical real-time processing center. | 27. Seismic receiver data collection |
| 1. Navigation artificial satellite                     | 28. Control display                  |
| 2. Radio navigation system                             | 29. Tape recorders                   |
| 3. Radio geodesy system                                | 30. Memory bus                       |
| 4. Sputnik receiver                                    | 31. DMA multiplanner                 |
| 5. Receiver indicators: Dekha, Lorenz, Omega           | 32. Interface                        |
| 6. Gyrocompass   | 33. Control                          |
| 7. Doppler instrument                                  | 34. Interface                        |
| 8. Speed measurement                                   | 35. Disk memories                    |
| 9. "Polak" radio geodesy receiver-indicator            | 36. Interface                        |
| 10. Interface  | 37. Special processor                |
| 11. Magnetic gradient meter                            | 38. Interface                        |
| 12. On-board gravimeter                                | 39. Tape recorders                   |
| 13. Rudder assembly                                    | 40. Interface                        |
| 14. Interface  | 41. DMA bus                          |
| 15. Automatic radar                                    | 42. Display                          |
| 16. Converter  | 43. Punch tape                       |
| 17. R-10 computer center                               | 44. Printer                          |
| 18. Display  | 45. Multiplication-division block    |
| 19. x-y plotter  | 46. Floating decimal block           |
| 20. Display  | 47. Seismic plotter                  |
| 21. Printer  | 48. Seismic plotter                  |
| 22. Magnetic tape                                      | 49. Disk memory                      |
| 23. Aero oscillators                                   | 50. Clock                            |
| 24. Piezo conversion                                   | 51. Interface                        |
|  | 52. Input-output bus                 |
|  | 53. R-10 computer center             |
|  | 54. Interface                        |

The most frequently used algorithms of the special processor are the following:

- calculation of the arithmetic mean,
- putting in dynamic corrections, according to the given speed function,
- transformation from floating decimal to fixed decimal,
- carrying out convolution with discrete functions,
- carrying out recursive filtering,
- transmitting blocks of data,
- scaling.

Demultiplexing takes place simultaneously with format transformation of the data provided by the seismic receiving instrument into a floating decimal 4 byte form, and the data go by continuous channel to disk memory.

The special color plotter used to display the data processed by computer technology also merits mention; it could be introduced in other areas of computer technology also (Figure 2). This seismic plotter is of the drum type and writes

on normal paper, eliminating the development procedures for optical plotters. The vibrating tongue of the plotter gives a digital rendering at a frequency of 5 kHz in points  $0.15 \times 0.1$  mm. It carries out autonomous profile write-out with the aid of its own internal 3 Kbyte memory. The write-out modes correspond to the norms generally used in seismic apparatus writing (changing area, wave writing and combinative form). The precision of writing is 0.1 mm. The seismic plotter can also be used as a color plotter, in the multi-head version. It is useful to use this primarily in the delayed pre-processing mode when the ship is not making profiles, because of storms or because it is in port, and it is possible to study the profiles in more detail. Color representation embraces a large dynamic range, for example 12 dB per color, which cannot be handled in a black and white seismic visual rendering. The colors show amplitude or frequency relationships, providing significant extra information for interpreting the profiles.

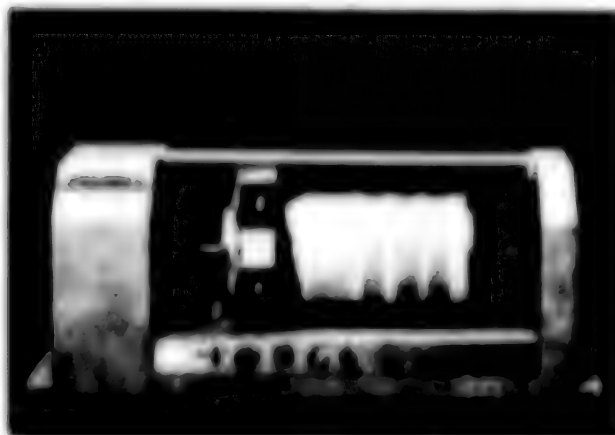


Figure 2. The color plotter.

#### The Software System for Ocean Research and Its Performance

The real-time presentation program package for time profiles contains the more important operations shown in Figure 3. In general the real-time data collection and processing shown require 20 seconds. The interval for sampling incoming data is 2-4 ms. Express profile editing can take place with a presentation of all channels or individual selected channels (Figure 4).

The program system prepares a protocol on a fast printer concerning all parameters of measurement and processing, changes therein and errors or other events. A monitor serves the geophysical system itself, instrument by instrument, the daily productivity of which, for example in 12-fold summation operation, can reach 700 kilometers. The technical-economic indexes of the MARS system correspond to those of a few similar systems used around the world (for example, Holis-Hedberg and Guilfrea).



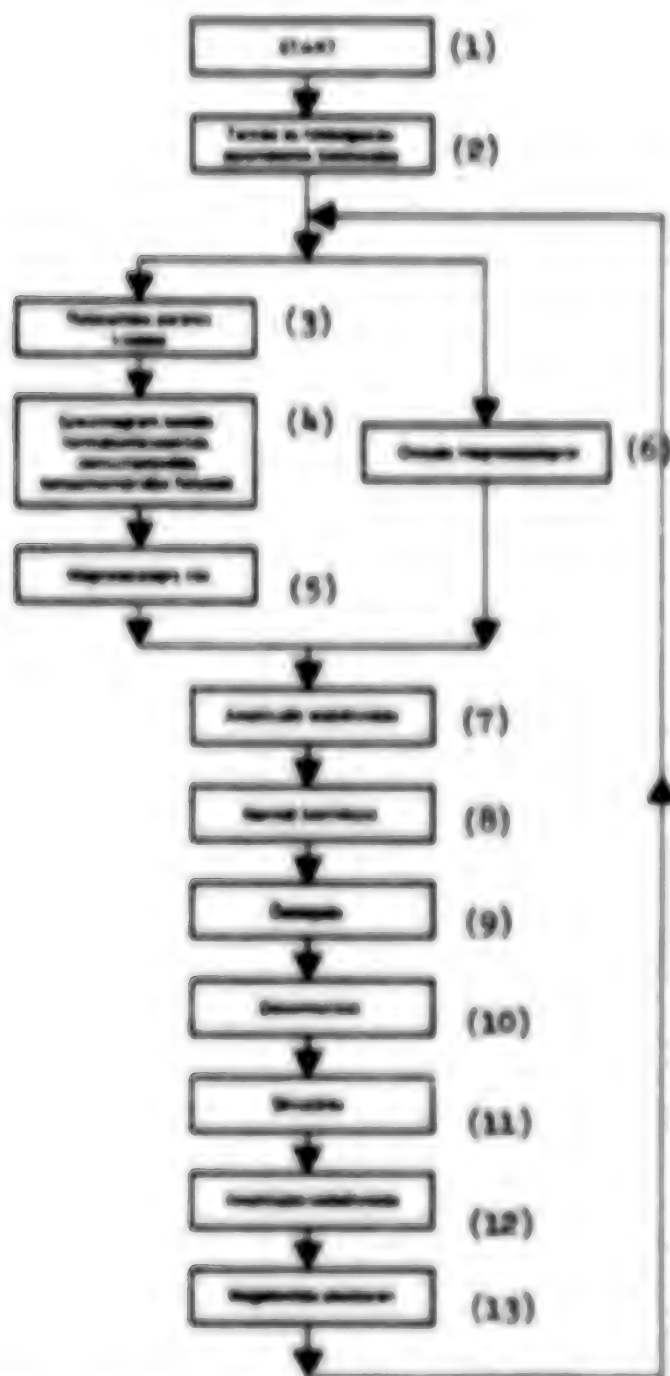


Figure 3. Flow chart of the real-time maritime pre-processing system.

Key:

1. Start
2. Read-in of conversion and processing parameters
3. Issue of explosion command
4. Salinogram in-put, format transformation, demultiplexing, disk memory in-put

[Key continued on following page]

5. Writing on magnetic tape
6. Reading from magnetic tape
7. Amplitude control
8. Normal correction
9. Summation
10. Deconvolution
11. Band filter
12. Amplitude control
13. Display on plotter

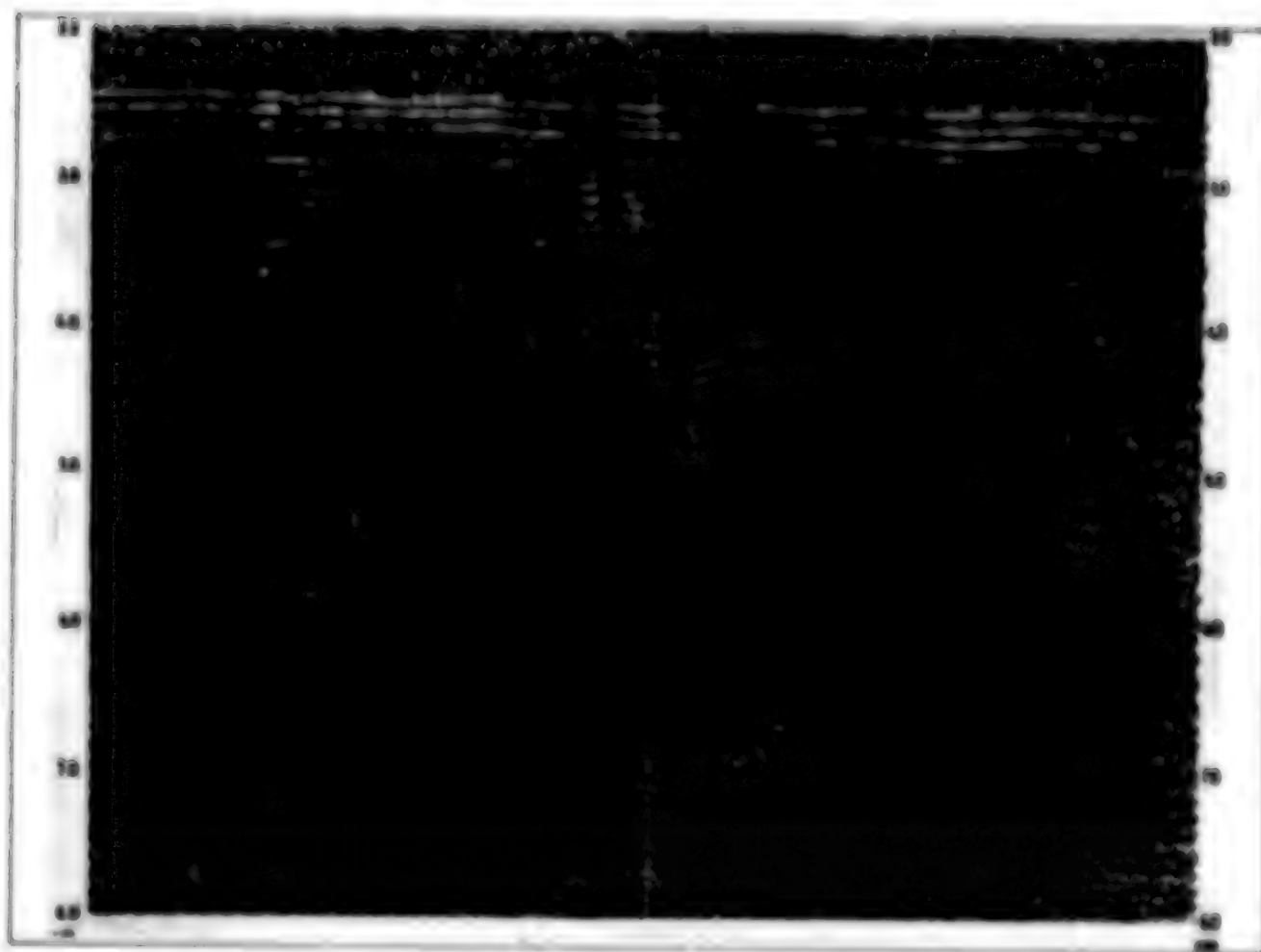


Figure 4.

In cooperation with the Oceanological Institute of the Scientific Academy of the Soviet Union the system for ocean raw materials research has also been used in other areas of interest to scientific oceanography. In addition to geophysical measurements the oceanographic programs measure and process about 50 hydrodynamic, meteorological, water pollution, radioactive, acoustic, etc. parameters. Another 8-10 computer became necessary to service this extended detector network. The linking of the processors and optimization of data processing among the several computers became absolutely necessary in this version.

#### Further Development of the MARS System

On the basis of the success of and experiences with the first generation of the real-time pre-processing system family the institutes participating in the program have made preparations for a new generation, the base computers of which will be the 8-11 computers of Videoton. The 8-11 has a number of properties which will be advantageous for performing ocean research tasks; for example, DMA, a larger memory, micro-programmed peripheral interfaces and increased capacity disk memories. At the same time we shift to the new computers we will modernize the peripherals and special geophysical instruments so that the entire system can meet the increased geophysical requirements of ocean research.

8984

CBO: 2502

## NEW OCEANOGRAPHIC RESEARCH VESSEL

Moscow TRUD in Russian 24 Jan 81 p 4

[Excerpt] Today in the Finnish city of Rauma they will raise the USSR state flag and the pennant of the USSR Academy of Sciences on board the diesel ship "Akademik Nikolay Keldysh." This scientific research ship was built in the Holming shipyard on the order of and with the specifications of Soviet scientists. Deputy Director of the USSR Academy of Sciences Institute of Oceanology imeni P. P. Shirshov, Doctor of Geographical Sciences A. A. Aksenov, talked about the new ship to TRUD correspondent Ye. Isakova.

The "Akademik Nikolay Keldysh" is a ship with a displacement of 5,500 tons. It is a modern, comfortable vessel built especially for hydrophysical investigations. On the outside the ship appears very unusual: the ship is asymmetric along its axis. All the superstructure of the top deck is completely displaced to one of the sides. The free part of the deck is entirely available for the carrying out of outboard operations work. Winches, underwater equipment and tools are placed here for investigations. On the ship there are 15 stationary laboratories equipped with the latest innovations in equipment, 4 moveable laboratories in containers and a computation center.

The maneuvering capabilities of the scientific ship are interesting. It can move both forward and backward, to the right and left perpendicular to its sides. Such movement is carried out with assistance from the "Akvamaster" apparatus. Also on board the ship is an integrated navigational system. Tests of all the mechanisms and apparatus will be made on its first voyage, to the Caribbean Sea region. A comprehensive scientific program will also be carried out. There will be biologists, geologists, geophysicists and hydrophysicists aboard the ship. The seven-kilometer deep Puerto Rico trench is the deepest place in the Atlantic Ocean. There oceanologists will make experiments with a deep-sea, narrow-beam echo sounder. Cuban and Mexican scientists will participate in the investigations.

In the future the ship will basically be used for hydrophysical research.  
(82-P)

#### BRIEFS

'PROFESSOR ZUBOV'-- The science ship "Professor Zubov," while undertaking a voyage to the high southern latitudes, visited Waterloo Island. A new shift of workers of the Bellingshausen station, headed by Candidate of Geographical Sciences A. Yanison, disembarked there. Three biologists from the GDR also remained to winter there. When they resumed the voyage, Captain V. Usolin guided the ship through the stormy Drake Passage in the Pacific Ocean sector of Antarctica. While carrying out various observations in accordance with the program "Polyarnyy Eksperiment-Yug" they obtained interesting data concerning the energy of cyclic winds of frontal zones. They are measuring the content of gases and water vapor in the atmosphere, as well as the characteristics of the interaction between air and water masses. The basic region for the work will be the waters of the South Pacific Ocean between New Zealand and Antarctica. [Text] [Moscow VOIENNY TRANSPORT in Russian 12 Feb 61 p 4]  
[98-P]

## MECHANISM OF FORMATION OF A TEMPERATURE INVERSION IN THE NEAR-WATER ATMOSPHERIC LAYER OVER THE SEA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 4, 1980 pp 829-832

KHUNDZHA, G. G. and ANDREYEV, Ye. G., Moscow State University, manuscript submitted 3 Jul 80

[Abstract] Since 1969 systematic studies have been made to ascertain the temperature profile in the near-water layer in the open sea using new methods and instrumentation. Gradient observations are not made from a ship, but from a float system at a considerable distance from a drifting ship. Multiday observations made in different regions of the sea under different hydrometeorological conditions during the spring-summer and autumn seasons during an expedition in the Black Sea on the "Moskovskiy Universitet" indicated that in the near-water layer the superadiabatic distribution of temperature at the sea surface in the half-meter layer passes into an inversion distribution. On the average the temperature difference in the inversion layer attains values  $\sim 0.5^{\circ}\text{C}$  and the layer itself stably exists during both the daytime and nighttime. The maximum temperature is in the thin layer lying between the layers with a superadiabatic and inversion temperature distribution. This part of the profile can be called the layer with an extremal temperature distribution. With such a temperature profile in the near-water layer, due to the presence of temperature gradients there should be heat transfer from the warm extremal layer into the adjacent upper and lower layers, where the temperature is lower. An interesting phenomenon in the forming of a temperature inversion is the process of dilution of gases and the associated thermal effect which could exist with the mixing of air with water vapor entering the near-water layer from the sea surface. In this process the moist air can be visualized as a two-component mixture consisting of nitrogen molecules and water vapor. As a result of mixing with nitrogen with height the vapor concentration will decrease and the mean distance between the molecules increases. The potential energy of the interaction among the molecules will decrease, which leads to an increase in the kinetic energy of the molecules, that is, an increase in the temperature of the mixture (moist air). Therefore, there will be a thermal effect of mixing, leading to the formation of a temperature inversion in the zone of intensive mixing of vapor with the air in the initial sector of the near-water atmospheric layer over the sea. Since the moisture flux, with rare exceptions, is directed from the ocean into the atmosphere, in the near-water layer over the ocean there is always an inversion layer and a layer with an extremal temperature value. In turn, the appearance of a temperature inversion leads to stability of the lower part of the near-water layer and a decrease of vertical exchange of moisture and heat. Thus, the processes of dilution of gases in the near-water layer and the formation of a temperature inversion layer play an important role in the self-regulation of heat and moisture exchange between the ocean and the atmosphere. Figures 2; references: 8 Russian, 3 Western.

[39-5303]

# **SOME RESULTS OF INVESTIGATIONS OF THE CHARACTERISTICS OF DEEP STRUCTURE OF WIND WAVES IN THE COASTAL ZONE OF THE SEA**

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan-Feb 81 pp 103-109

VAYSBAND, V. B., FURSON, A. A., Southern Division, Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 28 Aug 78, resubmitted after revision 29 Aug 80

[Abstract] In the coastal zone of seas, when wind surface waves are present, wave oscillations may arise which are known as "surf beats." An investigation of such oscillations is of great theoretical and practical interest because they are the reason for resonance oscillations of internal waters in ports and gulfs. However, investigations of this phenomenon have been limited by the complexity and unwieldiness of methods for the processing and analysis of initial data and the need for measuring a great number of waves. Clarification of the nature of the group structure of waves requires far longer records of wave heights than are obtained in standard observations. In actuality, in the study of wave groups it is necessary to employ the envelopes of groups, not individual waves. The article gives the results of investigations based on in situ observations in Gelendzhikskaya Bay. The measurements were made 400 m from the shore where the depth was 5.5 m. The sensor signal was fed by cable to an on-shore automatic recorder. The records of rises of the free surface of the sea by means of a semiautomatic digital converter were punched on tape in a binary code with a discreteness of 0.5 sec; the punched tape was then fed into an electronic computer. This frequency made it possible to obtain reliable information on waves with a period  $T \geq 1.0$  sec. Ten series of observations for different wind-wave conditions were made. Correlation and spectral analysis leads to the conclusion that when waves exist in the open sea in Gelendzhikskaya Bay there are two types of low-frequency oscillations which differ with respect to period. One, of the "surf beats" type, with a period 0.3-0.8 min, is formed due to the group structure of wind waves. The second, with a period close to 1.0-1.5 min, is determined by long-period waves arising in the open sea. Figures 4, tables 2; references: 6 Russian.

[86-5303]

UDC 551.465.55

# **MODEL OF SHORT-RANGE HYDRODYNAMIC PREDICTION OF CURRENTS**

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 939-946

SARKISYAN, A. S., SEMENOV, Ye. V., ALLAKHVERIDOVA, T. S., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 12 Jul 79, resubmitted after revision 18 Mar 80

[Abstract] At present there are very few models for the short-range prediction of currents. The principal difficulty is computation of gradient currents with full allowance for the advection of heat and vorticity. In the schemes and indirect



methods now used for the prediction of currents advective processes are taken into account only with the use of approximate climatic data or with allowance only for the drift component of currents in the upper layer of the ocean, which is unsatisfactory. Another requirement on the modeling of processes of rapid evolution of surface currents is the need for reproducing the upper quasihomogeneous layer. The rapid processes of interaction between the atmosphere and ocean take place through the upper quasihomogeneous layer. This article proposes a formulation of the problem of short-range forecasting of currents as a solution of a full system of equations in hydrodynamics. It makes it possible to use a direct method for taking advective processes into account and gives a simplified variant of a model of the upper quasihomogeneous layer. In the model use is made of factual data on water temperature at the surface of the northern part of the Atlantic Ocean obtained at the USSR Hydrometeorological Center. The study makes it clear that heat advection must be taken into account in short-range predictions of water temperature and currents. Figures 3; references 18; 16 Russian, 2 Western. [62-5303]

UDC 551.481.1:551.465.15

#### CHARACTERISTICS OF TURBULENCE, LANGMUIR CIRCULATION AND INTERNAL WAVES IN A LAKE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 947-953

FILATOV, N. S., RYANZHIN, S. V. and ZAYTSEV, L. V., Limnological Institute, manuscript submitted 6 Jul 79

[Abstract] Experimental investigations of recent years have shown that in large lakes, like in seas and oceans, there are similar characteristics of the quasihomogeneous layer -- fine microstructure, intermittence, Langmuir circulation, etc. This circumstance indicates an identity of the processes of formation of the quasihomogeneous layer and the relative simplicity in formulating precise measurements in a fresh-water lake makes it possible to regard a large stratified lake as a natural model of the ocean. In Lake Ladoga a moving base, a scientific research ship and autonomous buoy stations, were used in measuring the parameters whose determination at sea involves great difficulties. First, synchronous measurements of the components  $u'$  and  $w'$  of fluctuations of velocity  $T'$ , on the basis of which the fluxes of momentum and heat were computed, second, measurements of the vertical component of current velocity in zones of convergence of Langmuir circulation. Fluctuations of flow velocity were made with a d-c thermocouple. The longitudinal  $u'$  and vertical  $w'$  components of velocity fluctuations were discriminated by the summing and subtraction of signals received from two platinum filaments with a thickness of  $20\mu\text{m}$  and a length of  $8\text{ cm}$ , oriented at an angle of  $\pm 45^\circ$  to the direction of the mean flow. The observations of currents in a polygon of 16 buoy stations in Lake Ladoga gave two-frequency and frequency-time spectra for synoptic and mesoscales of current variability. An analysis of these data indicated that Langmuir circulations play an important role in forming the upper mixed layer. Some models of turbulent mixing are compared with experimental results. Figures 5; references 18; 16 Russian, 2 Western. [62-5303]



# INSTABILITY OF THE EKMAN BOUNDARY LAYER AND THE GENERATION OF INERTIAL WAVES IN A BAROTROPIC OCEAN

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 2, Feb 81 pp 190-198

BOKOLOV, V. A. and POMIN, L. M., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 14 Nov 79, resubmitted after revision 15 Feb 80

[Abstract] The authors obtained a numerical solution for the nonlinear problem of wind currents in an ocean of constant depth. It follows from the solution that the thickness of the Ekman layer varies periodically with an amplitude of about 20 m. Simultaneously with the development of the drift current, inertial velocity fluctuations arise in the form of waves having vertical and horizontal components of phase velocity. The region of existence of inertial fluctuations is propagated downward with a velocity of about  $10^{-1}$  cm·sec $^{-1}$ . The vertical phase velocity of the waves is directed upward and has a value of about 1 cm·sec $^{-1}$  and a length of the vertical wave of about 600 m. Horizontally the inertial waves are propagated southward with a velocity 4-5 cm·sec $^{-1}$ ; the length of the horizontal wave is about 2-3 km. The period of the inertial waves obtained in the solution is 20% less than its local value. The parameters of the inertial velocity waves change vertically. The mechanism of wind generation of inertial waves in the ocean is related to the instability of the Ekman layer arising due to rotation and accompanied by an exchange of energy between movements of different scales. Figures 4; references 16: 3 Russian, 13 Western.  
[118-5303]

# NONLINEAR DEVELOPMENT OF WIND WAVES IN A WEAK WIND

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 985-988

FABRIKANT, A. L., Institute of Applied Physics, USSR Academy of Sciences, manuscript submitted 21 May 1979

[Abstract] Taking into account the narrowness of the spectrum of wave numbers generated by a weak wind, it was possible to propose a method for describing wind waves. The growth of surface waves in the instability range is limited by at least two mechanisms. The first is related to the inverse influence of surface waves on the profile of mean wind velocity and the resulting decrease in the Miles increment. This "wind" nonlinearity leads to the formation of a current of the "cat's eye" type at the critical level where the wind velocity is equal to the phase velocity of the wave. However, random velocity fluctuations in the turbulent wind disrupt the "cat's eye" and prevent a decrease in the increment. The second limitation mechanism is related to the energy exchange between the wave harmonics due to

"hydraulic" nonlinearity. Nonlinear effects of this type can be computed by neglecting the influence of the air, that is, by considering the water surface to be smooth. Taking these considerations into account, the author neglects "wind" nonlinearity and thereby reduces the influence of air flow on surface waves to the exponential instability of these waves. In this approximation different possibilities of slightly nonlinear limitation of the growth of a quasimonochromatic wave are considered. Both three- and four-wave processes are taken into account. An equation is derived for the nonlinear evolution of a deep-water wave near the threshold of wind instability. Various aspects of the phenomenon are analyzed and described. Figures 1; references 15: 8 Russian, 7 Western.  
[62-5303]

UDC 551.465.752

# SOME RESULTS OF NUMERICAL MODELING OF LABORATORY EXPERIMENTS FOR STUDYING THE STRUCTURE OF AN AIR FLOW OVER WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 989-991

MAKIN, V. K., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 3 Sep 79

[Abstract] A numerical model of wind-wave interaction formulated by D. V. Chalikov (J. FLUID MECH., 87, 561-582, 1978) was applied successfully in modeling a laboratory experiment by R. H. Stewart (J. FLUID MECH., 42, 733-754, 1970), who investigated the kinematics of turbulent flow over monochromatic waves. The computations revealed that the model well reproduces the fine peculiarities of flow structure: vertical distribution of the amplitudes and phases of wave disturbances of velocity. Exploring this problem further, this article gives the results of numerical modeling of still another laboratory experiment (K. Takeuchi, et al., J. FLUID MECH., 80, 535-559, 1977), who also measured wave disturbances of velocity under a monochromatic wave, and also a unique experiment (O. H. Shemdin, et al., J. FLUID MECH., 30, 403-416, 1967) in which there was a study of the distribution of the pressure created by an air flow near the surface of monochromatic waves. The latter measurements were made in a large aerodynamic channel 25.9 m in length in which the wave producer generated sinusoidal waves with a length  $L = 655$  cm and an amplitude  $a = 5.25$  cm. The water depth was 0.9 m, the phase velocity of the wave was  $c = 262$  cm/sec and the frequency was  $\omega = 0.4$  sec<sup>-1</sup>. A detailed description of the numerical model used for the computations in this article was given by the author in OKEANOLOGIYA, 19, No 2, 1979. Several variants of the computations were made for a height of the boundary layer 300 cm. An increase in the height of the boundary layer leads to an increase in the phase shift and an increase in the pressure amplitude. This result shows that the structure of the flow is essentially dependent on the thickness of the boundary layer proper. A table gives data on the components of the total energy flux in the water. With an increase in the wind the energy flux to the wave increases. Figures 4, tables 1; references 11: 4 Russian, 7 Western.  
[62-5303]

## DISCRETENESS OF REFLECTING BOUNDARIES OF OCEANIC CRUST

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 7, 1981 pp 332-337

KOGAN, L. I. and MALOVITSKIY, Ya. P., Southern Division, Institute of Geology Im. P. P. Shirshov, Gelendzhik, manuscript submitted 30 Apr 80

[Abstract] A distinguishing characteristic of deep seismic sounding-reflected waves method sections obtained under a diversity of seismogeological conditions is the absence of extensive reflecting boundaries and the presence of strong diffracted waves in the main layers of the oceanic crust below the sedimentary stratum. The use of numerous procedures for the processing of multichannel seismic records on an electronic computer, including D-transformations, has not made it possible to obtain reflecting boundaries with an extent greater than 10-15 km and subhorizontal reflecting surfaces with an extent of 2-3 km are the principal elements of processed time sections obtained by the deep seismic sounding-reflected waves method. A review of the literature and analysis of the different methods employed in such analyses made it possible to draw the following conclusions. 1. A statistical interpretation of such data obtained in different parts of the world ocean made it possible to establish the discreteness of reflecting boundaries in the oceanic crust below the sedimentary layer within the limits of zones of spreading structures. 2. The discreteness of the reflecting boundaries of the main layers of the oceanic crust is governed by its block structure. 3. The discreteness of the blocks (discreteness of the reflecting boundaries) varies from 2-5 to 10-15 km and is dependent on the rate of formation of the oceanic crust. 4. The blocks are separated by heterogeneous zones of dislocations whose nature can be different. The most characteristic dislocations are of the vertical fault bench type. 5. In provinces with a rapid crustal growth (rate more than 3 cm/year) the mean extent of the blocks is 1.0-1.5 km (third layer) and increases to 2.0-2.5 km for the second layer. 6. In provinces with a slow growth of the earth's crust the mean extent of the blocks is 2.4 km for the second layer and 1.0 km for the third layer. 7. A detailed statistical analysis of the extent and structure of the blocks, type of heterogeneity, zones of dislocations and the determination of their relationship to the age and rate of formation of the earth's crust will probably make possible a considerable supplementation of existing concepts concerning the genesis of different structural provinces of the ocean floor, in particular, the process of oceanic riftogenesis. 8. Statistical interpretation models, computed for heterogeneous systems, are most acceptable in an analysis of data from deep seismic profiling of the ocean floor by the reflected waves method. Figures 3; references: 13 Russian, 2 Western.

[73-5303]

# TEMPERHALINE STRUCTURE AND MIXING TRACES IN SYNOPTIC EDDIES AND RINGS IN THE GULF STREAM

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 23-29

FEDOROV, K. N., GINZBURG, A. I., and ZATSEPIN, A. G., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 26 Dec 79, resubmitted after revision 19 May 80)

[Abstract] On the basis of the results of measurements made on the 27th voyage of the scientific research ship "Akademik Kurchatov" under the POLINORD program, the authors analyze the characteristics of the thermaline structure in eddies (cyclonic and anticyclonic) and rings in the Gulf Stream (warm and cold). It is postulated that  $\theta$ ,  $\delta$  anomalies, the anomalous distribution of oxygen and pH observed in eddies, could be caused by mixing in connection with vertical movements in the cores of eddies or as a result of water exchange between neighboring eddies of opposite sign. On the other hand, temperature inversions in the upper layer 50-250 m in Gulf Stream rings in all cases are associated with intrusion interlayering on fronts separating the cores and shells of the rings. A comparison of the positions of cold intrusions of anticyclonic and cyclonic rings on the T,  $\delta$  diagram demonstrates that they are of fundamentally different origin. All the points corresponding to intrusions of warm anticyclonic rings lie beyond the limits of the T,  $\delta$  region characterizing the waters of the rings themselves and all the points of intrusions of cold cyclonic rings lie within this region. On the basis of the position of the intrusions on the T,  $\delta$  diagram it can be concluded that the intrusions discovered on the periphery of a warm ring constitute an entrainment of the flow of shelf waters propagating from the north along the eastern boundary of the ring to its southern periphery. Cold intrusions of cyclonic rings are encountered far closer to the center of the ring and consist of the transformed slope waters of the core, penetrating into the shell, formed by waters of the Gulf Stream, possibly under the influence of centrifugal forces. Figures 3; references 6; 3 Russian, 3 Western.

[92-5303]

UDC 551.463.5

## RELATIONSHIPS BETWEEN SOME HYDROOPTICAL PARAMETERS

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 51-54

SHUMSHURA, V. Ye. and FEDIRKO, V. I., Hydrophysical Institute, Ukrainian Academy of Sciences, manuscript submitted 9 Oct 79, resubmitted after revision 29 Feb 80)

[Abstract] Specialists in the Optics Section Marine Hydrophysical Institute Ukrainian Academy of Sciences have designed an instrument making possible direct determination of the I value, the color index of the water. Its operating principle, the measurement method and the results of the first investigations were given by



N. Ye. Lu, et al., in *MORSKIYE GIDROFIZ. ISSLED.*, No 1(72), 1976. It has been found that there is a dependence between the depth of visibility of a white disk and the color index. In waters with an attenuation index from 0.07 to 0.4  $m^{-1}$  this correlation is expressed by the regression equation  $1/l = A + B 1/c$ , with a correlation coefficient close to 0.9. However, there was an inadequate statistical support for this finding and therefore the authors felt it was necessary to carry out additional investigations. A study was made of data obtained at 124 points in different regions of the world ocean. Use was made of instruments with both glass and interference light filters having maximum wavelengths in the first case equal to 540 and 440 nm and in the second case 565 and 444 nm. The range of change in the depth of visibility of a white disk was from 3 m (northwestern part of the Black Sea) to 44 m (southern tropical convergence zone of the Indian Ocean). Measurements of  $K_d$  ( $d =$  disk) were made both in sunny weather and in the presence of cloud covers of different type. Using these data it was possible to analyze the dependence of the color index of water on the color of sea water determined using the Foral-Ule scale against the background of a white standard disk lowered to half the depth of its disappearance. Sixty spectral measurements of  $l$  were made and color determinations were made. The depth of visibility of the white disk varied from 1 m (Black Sea, region of the Danube mouth) to 45 m (equatorial part of the Indian Ocean). These studies revealed that the color index of water can be estimated both from the depth of visibility of a white standard disk and from the color of the sea determined using the Foral-Ule scale. In both cases the accuracy in evaluating  $l$  is adequate for solving a number of practical problems. (92-5303)

UDC 535.372:541.14

#### USE OF A LASER SPECTROFLUORIMETER IN MEASURING THE CONCENTRATIONS OF MARINE PHYTOPLANKTON PIGMENTS

Moscow *OCEANOLOGIYA* in Russian Vol 21, No 1, Jan-Feb 81 pp 174-179

DENIDOV, A. A., BAULIN, Ye. V., FADEYEV, V. V., SHUR, L. A., Physics Faculty, Moscow State University and Physics Institute Siberian Department USSR Academy of Sciences, manuscript submitted 23 May 80, resubmitted after revision 14 Sep 80]

[Abstract] The article describes the development of a method for measuring extremely low concentrations of phytoplankton pigments in acetone extracts obtained from a small volume of an initial sample of sea water and testing of an express method for the analysis of the concentrations of chlorophyll "a" in phytoplankton directly in sea water samples. The basis for measurements was the laser spectrofluorimetry method. The instrument is described (a block diagram is included) and the method is outlined. It is shown that by using laser spectrofluorimetry it is possible to measure the concentrations of chlorophyll "a" and pheophytin "a" in initial samples of sea water and in extracts with an error  $< 20\%$  in regions with an extremely low phytoplankton content. Formulas are derived for determining the concentrations of these substances from acetone extracts and initial sea water samples. Under expeditionary conditions measurements of chlorophyll "a" were made in the initial samples by an express method in the range 0.1-0.62  $\mu g \cdot liter^{-1}$  and

from acetone extracts in the range  $0.002-0.02 \mu\text{g} \cdot \text{liter}^{-1}$ ; for this purpose it was sufficient to filter only 2 liters of sea water (standard methods would have required more than a 100-liter volume). Figures 2; references 8; 3 Russian, 5 Western.  
[92-5303]

UDC 551.463

#### ESTIMATION OF THE THICKNESS OF THE MAIN OCEAN THERMOCLINE

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 19-24

RYABININ, V. I., USSR Hydrometeorological Center, manuscript submitted 22 Feb 80, resubmitted after revision 10 Jun 80

[Abstract] The analytical modeling of circulation in a baroclinic ocean is greatly complicated by the nonlinearity of the differential equations. The special character of the known solutions makes it possible to investigate only a case when the functions describing the horizontal distributions of water density at the ocean surface and wind shearing stress are related in such a way that with a downward directed vertical velocity on the lower boundary of the Ekman layer the water temperature drops off to the east. This result is actually confirmed by observations in the region of the subtropical anticyclonic circulation. In such a model the meridional temperature gradient with a stipulated wind is dependent on an arbitrary constant related to the index of decrease of temperature with depth. Accordingly, the author has found the value of this constant, leading to a fair agreement with observations of both the horizontal and vertical distributions of water density in the circulation. The most important result is a confirmation of the possibility of correct description of the vertical and horizontal distribution of water density in the ocean with one and the same values of the constant  $c$ . The author thoroughly validates the choice of this constant in models of a baroclinic ocean with a temperature decreasing exponentially with depth. Tables 1; references 16; 7 Russian, 9 Western.  
[92-5303]

UDC 551.466.31

#### DISPERSION CHARACTERISTICS OF WIND WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan 81 pp 59-66

ZASLAVSKIY, N. N., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 4 Oct 79, resubmitted after revision 26 Feb 80

[Abstract] The author's objective was a discussion of the problem as to the extent to which for real wind waves it is possible to accept the idea of their closeness to linear free gravitational waves with the usual dispersion relationship

$$\omega = \pm \sigma(k) = \pm (gk + Tk^3)^{1/2}$$

( $g$  is the acceleration of gravity,  $\gamma$  is the coefficient of surface tension at the water-air interface, normalized to water density). The qualitative estimates presented here show that in the spectrum of well-developed wind waves it is possible to expect the presence of two characteristic regions: 1) the energy-carrying components of waves, which are close to free linear waves with respect to their dispersion characteristics; 2) short gravitational and gravitational-capillary waves which with respect to their dispersion characteristics are more similar to ordinary turbulence than to linear free waves. It is therefore concluded that the concept of closeness of real wind waves to linear free waves must have a rather limited region of applicability; it can be used with sufficient reliability only for the energy-carrying components in the neighborhood of the spectral maximum and only in the case of sufficiently well-developed wind waves. Figures 2; references 9; 7 Russian, 2 Western.  
[86-5303]

UDC 551.466.61

#### PROPAGATION OF LONG NONLINEAR WAVES IN A LAYER OF ROTATING FLUID

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan-Feb 81 pp 76-81

SHKINA, V. I., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 16 Jul 79, resubmitted after revision 26 May 80

[Abstract] A study was made of long nonlinear gently sloping waves in a layer of rotating fluid. An equation is derived which takes into account the nonlinearity, dispersion and slight dependence on the transverse coordinate. For plane movements in the approximation of hydrostatics the derivation of this equation does not require a smallness of the nonlinear terms. Plane stationary waves were investigated, including a critical wave of a limiting amplitude. A two-dimensional nonlinear Schrödinger equation was derived for describing the evolution of a packet of slightly nonlinear waves. This equation describes the effects of automodulation and self-focusing of waves, and also the collapse of the envelope. It is shown that all the results are applicable to the case of internal waves in a single-mode approximation. Figures 1; references: 10 Russian.  
[86-5303]

UDC 551.465

#### MODELS OF THE OCEAN IN THE HYDRODYNAMIC THEORY OF LONG-RANGE WEATHER FORECASTING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 6, 1980 pp 1344-1347

FEL'ZENBAUM, A. I., Moscow State University, manuscript submitted 31 Jul 80

[Abstract] In the theory of hydrodynamic long-range weather forecasting, being the central global problem of interaction between the atmosphere and ocean, it is the ocean model which is least developed, this being attributable for the most part to the difficulty in taking its upper layer into account. The author has dealt with

a very simple one-dimensional case (examining an equilibrium state of the upper layer of the ocean) in his earlier studies (DOKLADY AN SSSR, Vol 255, No 3, 1980; Vol 255, No 5, 1980) and now has presented a general approach to modeling of the entire ocean. As a simplification, the model does not take salinity into account, the density of sea water being considered a linear function of its temperature. The author defines an upper quasihomogeneous layer, jump layer, seasonal thermocline, main thermocline and abyssal layers. It is assumed that the temperature in the deep layers is stipulated as a function of horizontal coordinates and is not dependent on time. Temperature above the deep layers is stipulated at the initial moment in time. The proposed method for computing temperature, the heat flow and current velocity in the ocean is based on the vertical parameterization of temperature and essentially involves solution of a system of equations including averaged (for the defined layers) equations of turbulent thermal conductivity and the energy balance equation for turbulence in the upper quasihomogeneous layer. The upper and lower boundaries of the main thermocline are stipulated as functions of horizontal coordinates and it is assumed that they do not change with time. The upper boundary can be selected at the maximum depth of penetration of the vertical winter circulation when the seasonal thermocline disappears. Among the formulas whose derivation is presented here are those for the upper quasihomogeneous layer, seasonal and main thermocline and the balance of turbulent energy in the upper quasihomogeneous layer. The system of derived equations is closed by the equation of state (the linear relationship between density and temperature) and the equation of horizontal motion, which can be adopted in different form in dependence on the extent to which allowance is made for such factors as the horizontal exchange of momentum and nonlinear accelerations. The initial conditions used are the mean climate, the annual variation computed from mean long-term data on the ocean and the atmosphere above it. The model developed here, in its different variants, can be used in solving problems related to long-range weather forecasting. Figures 1; references 15; 14 Russian, 1 Western. [70-5303]

UDC 910.2

## LAST EXPEDITION OF THE "VITYAZ"

Published VESTNIK AKADEMII NAUK SSSR in Russian No 2, Feb 81 pp 118-123

ALSENOV, A. A., doctor of geographical sciences

[Abstract] The final, 65th expedition of the scientific research vessel "Vityaz" began on 17 February and ended on 22 April 1979. The expedition had two principal objectives. The first of these was a multisided study of abyssal depressions of the Mediterranean Sea and the Iberian Basin in the Atlantic Ocean. These studies were a component part of the extensive scientific program "European Seas Under the Influence of the Ocean and Continents." The second objective was the organization of scientific conferences at ports of call for the familiarization of foreign specialists with the principal achievements of Soviet oceanology. The "Vityaz" was thereby terminating thirty years of research work, marked by major discoveries in the fields of biology, geology and hydrology. On the 65th expedition there were seven detachments: plankton, benthos, nekton, geology, geochemistry, hydrophysics, biochemistry. The author of this article headed the expedition. The



expedition's work was carried out in deep-water regions of the Mediterranean and in some relatively shallow-water polygons. Thirty-seven stations were occupied, at each of which investigations were made of plankton, nekton and benthos, hydrological observations were made and samples of sediments were collected. During the expedition use was made of bottom trawls, with regular employment of the GID-78 hydroacoustic bottom indicator. Using this instrument, suspended on the working cable of a trawl, it is possible to carry out continuous monitoring of the position of the catching gear relative to the bottom. The GID-78 assisted in regulating the length of the cable which was let out and in avoiding the jerks and fall-offs accompanying this work in the case of considerable depths. Mass determinations were made of compounds of iron, manganese and sulfur and for the first time under shipboard conditions it was possible to determine selenium in sediments. It was possible to make shipboard determinations of the absolute age by the radiocarbon method. Fifty-six absolute datings were obtained; in particular, it was possible to establish the age of volcanic ash intercalations associated with eruptions of Vesuvius. The hydrophysical detachment made extensive use of the "AIST" probe for continuous registry of the distribution of temperature and salinity with depth. An exceedingly uniform temperature was observed to a depth of 1,000 m. This was a result of a severe storm which raged over the Mediterranean Sea in the second half of February 1979. The scientists presented a series of reports at scientific centers in France, Spain, Portugal, Great Britain and Denmark. Figures 2.

[117-5303]

UDC 551.465.11

#### LOCAL PREDICTION OF SYNOPTIC-SCALE CURRENTS IN THE OPEN OCEAN

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 2, Feb 81 pp 182-189

REIDOV, D. G. and ENIKHARIV, G. M., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 26 Dec 79, resubmitted after revision 27 Feb 80

[Abstract] The authors propose a numerical model making it possible to simulate the thermohydrodynamics of open regions in the ocean, the objective being to make possible a local prediction of synoptic-scale currents. In a local model difficulties arise in the stipulation of boundary conditions because there are no natural boundaries where traditional conditions can be set. The state at the boundary of the region is dependent on the dynamics both in the internal part of the region and beyond its limits. The method for computing boundary conditions proposed by I. Orlandi (J. COMPUT. PHYS., Vol 21, No 3, 251-269, 1976) can be used for programmatic computations for a time comparable with the characteristic time of processes with a spatial-temporal scale close to synoptic (several hundreds of kilometers and 10-60 days) in a region with spatial dimensions of the same order of magnitude. Accordingly, the authors formulated a model of currents in an ocean region with open boundaries on the  $P$ -plane. In the simplified variant of the model presented in this paper bottom topography, vertical diffusion of heat and vertical turbulent exchange of momentum are neglected. The inertial terms and horizontal turbulent exchange of momentum are retained in vertically averaged equations of motion,

serving for determination of the mean vertical component of current velocity. The shear component of horizontal velocity is computed from geostrophic relationships. Density is assumed to be linearly dependent on temperature and salinity, which makes it possible to use one equation for the balance of mass instead of two balance equations, for heat and salt. The model was tested using data from hydrological surveys in the American NKEE experiment. The article gives preliminary results of numerical prediction of currents in the area. Figures 3; references 13: 6 Russian, 7 Western.  
[118-5303]

UDC 551.466.61

#### ROSBY NEW SOLUTIONS FOR ROSSBY SOLITONS

Moscow [IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan 81 pp 82-87

REBISTOV, A. L., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 14 Nov 79

[Abstract] The propagation of Rossby waves in the ocean is described by the equation for potential vorticity in a quasigeostrophic approximation, differing for barotropic and baroclinic fluids. In this article the author seeks solutions for these equations in the form of stationary waves propagating along the x-axis with the velocity  $c = \text{const}$ , the Väisälä frequency is considered constant and it is assumed that bottom relief changes only in a meridional direction. After rewriting the fundamental equations, the author considers solitary Rossby waves, being a precise solution of these equations. Efforts along these lines have been made by such authors as N. E. Stern (J. MARINE RES., Vol 33, No 1, 1-13, 1975) and G. R. Flierl (JOLINODE NEWS, No 62, 7-10, 1979). Here an effort is made to obtain a solution of the rewritten baroclinic equation similar to that obtained by Stern and Flierl, but then improve on their results. The shortcomings of earlier studies are noted and corrections are introduced. In addition, the experimental results obtained by Davis-Arrivos (J. FLUID MECH., Vol 29, No 3, 593-608) are considered applicable to planetary waves. Figures 2; references 5: 2 Russian, 3 Western.  
[86-5303]

## EFFECT OF HIGH-ORDER NONLINEARITY ON THREE-WAVE RESONANCE PROCESSES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan 81 pp 88-94

GONCHAROV, V. V., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 11 Nov 79

[Abstract] In problems of nonlinear propagation of waves of any nature an important role is played by three-wave resonance processes: decay instability, wave generation, energy transfer in the spectrum, etc. Accordingly, one of the problems in the nonlinear theory of waves is detection of resonance wave triplets and computation of the process of interaction among them. In the approximation of slight nonlinearity no allowance is usually made for the interaction of high orders (four-wave, etc.) because three-wave interaction already taken place in a quadratic approximation, and accordingly, should be more rapid. The characteristic velocity of the latter is proportional to the amplitude of the waves, whereas for a four-wave phenomenon -- proportional to the square of amplitude. However, as indicated in this paper, under some conditions three-wave processes will transpire slower than four-wave processes even in the case of quite small wave amplitudes. The author jointly considers three- and four-wave resonance processes in wave nonlinear interaction problems. In the general case of interaction of three waves it was possible to find the condition for the amplitude of a high-frequency wave when decay instability does not develop. The possibility of existence of this phenomenon in real situations is demonstrated in the example of interaction of surface and internal waves. It is also shown that third-order nonlinearity may serve as a stabilization mechanism in the parametric excitation of waves. Figures 4; references 5; 4 Russian, 1 Western.  
(86-5303)

UDC 551.463.5:535.36

## METHOD FOR COMPUTING BRIGHTNESS AT GREAT OPTICAL DISTANCES FROM RADIATION SOURCES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan 81 pp 102-105

DOLIN, L. S., Institute of Applied Physics, USSR Academy of Sciences, manuscript submitted 6 Jul 79, resubmitted after revision 5 Mar 80

[Abstract] The article describes a method for computing brightness at great optical distances from radiation sources. It is assumed that a homogeneous turbid medium fills the half-space  $z \geq 0$  and radiation with the brightness  $B_0(n)$  is incident on its boundary from the outside. It is known that at an adequate distance from the boundary ( $z \gg z_0$ ) the brightness field in the medium (with the scattering index  $\sigma \neq 0$ ) assumes the form

$$B(z, n) = Ae^{-\alpha z} D(\mu),$$

where the  $\alpha$  parameter (deep index of light attenuation) and the  $D(\mu)$  diagram (deep body of brightness) is not dependent on  $B_0$  and are determined by the optical characteristics of the medium,  $\mu = \cos \theta$ ,  $\theta$  is the angle between the direction of sighting ( $n$ ) and the  $z$ -axis. The author demonstrates that if the  $D$  diagram is highly anisotropic the amplitude factor  $A$  can be extremely simply expressed through  $B_0(n)$  and  $D(\mu)$ , without recourse to computation of the brightness field in the layer of the medium  $0 \leq z \leq z_0$ . An asymptotic expression is derived for the brightness field of a point monodirectional source. This expression also makes it possible to write a general expression for the asymptotic behavior of the brightness field of arbitrary sources distributed in a limited region in space. Figures 2; references 17; 15 Russian, 2 Western.

[86-5303]

UDC 551.465

#### MODEL OF MESOSCALE CIRCULATION IN THE OPEN OCEAN

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 5-11

NEYELOV, I. A. and CHALIKOV, D. V., Leningrad Division, Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 10 Oct 79, resubmitted after revision 2 Apr 80

[Abstract] The authors describe a numerical model with a high resolution intended for the reproduction of synoptic eddies in the ocean and the preliminary results of computations. The model is based on the primitive equations of dynamics, taking into account horizontal and vertical turbulent exchange of momentum and the density transfer equation. The source of available potential energy is the nonuniform distribution of the flux of mass at the ocean surface. A solution method which filters surface gravitational waves is described. The results of modeling of mesoscale circulation over a prolonged time interval are presented and information is given on the principal energy transitions and the qualitative characteristics of the dynamic regime. Figures 3; references: 1 Western.

[92-5303]

UDC 551.463

#### LABORATORY MODELING OF DEEPENING OF A MIXED LAYER OF FLUID

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 45-50

KREYNAN, K. D., Leningrad Hydrometeorological Institute, manuscript submitted 16 Jan 80

[Abstract] The principal content of this article is the results of laboratory experiments using different principles for the generation of turbulent energy in an investigation of the process of formation and fluctuations of the characteristics of a mixed layer of fluid in dependence on its initial stratification, heat flow from the surface and intensity of mixing. The modeling of the diffusion mechanism of mixing was carried out using an apparatus close in its design to that used in the experiments of Turner and Kraus, but the source of the turbulence generated in a

water-filled tank measuring  $0.3 \times 0.3 \times 0.8$  m was not a grid, but a perforated plate. Plates with a thickness of 0.25 cm with a diameter of the openings 0.85, 1.0 and 1.15 cm were used in the experiments. The distance between the centers of the openings in all the plates was the same: 1.5 cm. The frequency and amplitude of the oscillations of the mixing plate was monitored using a special electronic device. The design of the apparatus made possible an arbitrary change in the frequency of plate oscillations in the range 2.4-9.0 Hz with a constant amplitude of 0.8 cm. The heat flow from the surface was simulated using electric grid heaters which were sunk directly under the perforated plate. In the analysis of the results of laboratory experiments the heat flow fed into the basin was considered uniformly distributed over the area of the horizontal section of the tank and proportional to the power scattered on the heating elements, which was determined from the strength of the electric current and the voltage measured in the circuit of these elements. The heat flows in different experiments varied in the range  $(0.2-1.2) \cdot 10^{-2}$  cal·cm<sup>-2</sup>·sec<sup>-1</sup>. The geophysical applications of the laboratory experiments are discussed. The results indicate the feasibility and desirability of using laboratory apparatus for the modeling of regional hydrometeorological situations. Figures 5; references 10: 4 Russian, 6 Western.  
[92-5303]

UDC 534.24+537.876.23

#### REFLECTION OF PLANE WAVES FROM A STRATIFIED HALF-SPACE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 5, 1980 pp 1069-1072

GODIN, O. A., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 30 Jul 80

[Abstract] Different methods have now been found for obtaining precise solutions of the problem of reflection of a plane wave from continuously stratified media for a considerable number of specific laws of the dependence of properties of the medium on the Cartesian coordinate  $z$  perpendicular to the layers. In this article the author proposes a new approach which makes possible a unified examination of an extremely broad class of inhomogeneous media. The problem is formulated as follows. Assume that homogeneous and layered-inhomogeneous half-spaces bound on the plane  $z = 0$ . When  $z < 0$  the medium is homogeneous and the wave number is equal to  $k_0$ . A monochromatic plane wave

$$\exp i(\xi x + \sqrt{k_0^2 - \xi^2} z)$$

is incident from a homogeneous half-space. The field in the inhomogeneous medium is sought in the form

$$\psi(x, z) = \Phi(z) \exp i \xi x, \quad z > 0. \quad (1)$$

The  $\Phi(z)$  function then satisfies the equation

$$\Phi''(z) + [K^2(z) - \xi^2] \Phi = 0. \quad (2)$$

The physical sense of the  $\psi$  and  $K$  parameters is considered for: a) an acoustic case; b) in an electromagnetic case, when  $E$  lies in the plane of wave incidence



(vertical polarization); c) in an electromagnetic case when  $E$  is perpendicular to the plane of incidence (horizontal polarization). It is assumed that (2) has at least one limited solution. A reflected wave appears as a result of the effect of the inhomogeneous medium on the incident wave. If the  $\Phi(x)$  function is found, the reflection coefficient is found. Then it is possible to proceed directly to finding the field in the inhomogeneous medium. A series of formulas is derived which give the reflection coefficient for a plane monochromatic wave for any  $K^2(x)$  profile. It is shown that it is possible to construct a multiparameter family of profiles for which the problem is solved precisely. The application of this approach is illustrated in a specific example. References 13: 7 Russian, 6 Western. [33-5303]

UDC 551.465

#### MODELING OF THE UPPER LAYER OF THE OCEAN

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 5, 1980 pp 1080-1084

FEL'ZENBAUM, A. I., Moscow State University, manuscript submitted 31 Jun 80

[Abstract] Laboratory modeling of the upper layer of the ocean was undertaken in a study by L. H. Kantha, O. M. Phillips and R. S. Asad, J. FLUID. MECH., Vol 79, No 4, 753, 1977. They investigated purely dynamic entrainment in a two-layer fluid. The method for processing observational data in this experiment was the same as in an earlier experiment by H. Kato and O. M. Phillips, J. FLUID MECH., Vol 37, No 4, 643, 1969, carried out using the same laboratory apparatus, but with a continuously stratified fluid below the upper quasihomogeneous layer. In this article the author makes full use of these studies, also drawing upon the work of L. N. Kantha (OCEAN MODELING, No 25, 8, 1979), E. B. Kraus and I. S. Turner, TELLUS, Vol 19, No 1, 98, 1967, and E. L. Deacon and E. K. Webb, THE SEA, Vol 1, 1962. The author has integrated and developed all this work. On the basis of similarity theory, the results of laboratory experiments and observational data directly under natural conditions it was possible to arrive at a final one-dimensional integral model of the upper layer of the ocean. Figures 4; references 6: 1 Russian, 5 Western. [33-5303]

UDC 551.463

#### TRANSFORMATION OF THE $T_0$ WAVE FIELD IN A DEEP SECTION BY THE ISOCHRONAL METHOD

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 160-165

MOSKALENKO, V. N., Southern Division of the Institute of Oceanology, manuscript submitted 26 Nov 79, resubmitted after revision 6 Jun 80

[Abstract] The isochronal method is well known in seismic prospecting. In the form of ray diagrams it has been used in manual methods for the processing of seismic data. Analog apparatus has been developed for the processing of data from continuous seismic profiling by the isochronal method. This article gives the results of mathematical modeling of the isochronal method which, depending on the adopted velocity model of the medium, determine the region of applicability of different

methods for transforming the wave field into a deep section. Specifically, the author considers methods for transforming the wave field  $T_0$  obtained by single-channel seismic profiling. [ $T_0$  is the wave field of normally reflected rays.] Two types of model of the medium are examined. For a gradient half-space it is shown that with its replacement by a medium with a constant velocity or by a medium with an arbitrary law of velocity distribution with depth, but with circular isochronal lines, the transformation of the wave field introduces great distortions into the deep section. An approximate method is proposed for constructing isochronal lines with allowance for change of velocity in the section which introduces distortions not greater than 3%. Figures 2; references 6: 5 Russian, 1 Western. [92-5303]

UDC 551.466.31

#### SELF-SIMILAR SPECTRA OF WIND WAVES IN THE HIGH-FREQUENCY REGION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan 81 pp 50-58

BARENBLATT, G. I. and LEYKIN, I. A., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 28 Dec 79

[Abstract] The first self-similar spectra of wind waves were obtained by O. H. Phillips. He stated that the decisive parameters of the frequency spectrum  $S$  of gravitational waves are the frequency  $\omega$  and acceleration of gravity  $g$ . The expression derived was  $S = \beta g^2 \omega^{-5}$ , where  $\beta$  is a universal constant. The frequency spectrum for the case of slightly nonlinear waves was obtained by V. Ye. Zakharov and N. N. Filonenko in the form  $S \sim \bar{p}^{1/3} \omega^{-4}$ , where  $\bar{p}$  is the specific intensity of energy transfer from the wind to the waves. Experimental data of recent years revealed considerable deviations of the frequency spectra from the Phillips dependence. It was established that the value of the  $\beta$  parameter, which should be a universal constant, in actuality is not constant for different wave formation conditions and can differ by an order of magnitude or more. A still stronger difference between the experimental spectra  $S(\omega)$  and the Phillips expression was discovered in an investigation of the high-frequency interval of the spectra. Experimental studies also reveal deviations from the Zakharov-Filonenko spectrum. Accordingly, on the assumption of an incomplete self-similarity of the wind wave spectrum with respect to the dimensionless parameter  $u_0 \omega / g$  ( $u_0$  is wind velocity,  $\omega$  is frequency,  $g$  is the acceleration of gravity) the authors obtain a new form of the self-similar spectrum of wind waves in the equilibrium interval. The proposed spectrum takes in the Phillips and Zakharov-Filonenko spectra as special cases. Figures 2; references 18: 12 Russian, 6 Western. [86-5303]

## SOUND SCATTERING BY MULTISCALE INHOMOGENEITIES OF BOTTOM MATERIAL

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 42-44

IVAKIN, A. N., Acoustics Institute, USSR Academy of Sciences, manuscript submitted 3 Jan 80

[Abstract] Yu. Yu. Zhitkovskiy (IZV. AN SSSR: FIZIKA ATMOSFERY I OKEANA, Vol 4, No 5, 567-571, 1974) examined sound scattering by inhomogeneities of absorbing bottom material and derived an expression for the coefficient of backscattering of sound by the bottom

$$n_0 = (n_0 \sin \chi) / 2\beta,$$

where  $\chi$  is the glancing angle of an acoustic wave on the bottom;  $\beta$  is the absorption coefficient;  $n_0$  is the coefficient of volume scattering of sound in bottom material. Experimental investigations in shallow-water regions of the ocean indicated that  $n_0$  approximately to glancing angles 40-50°, and in some cases in the entire range of angles, conforms to a definite law, but at the same time it is not dependent on frequency in a broad frequency range (from 1 to 100 KHz). In this article it is shown that this effect can be caused by the multiscale character of bottom inhomogeneities. A model of absorbing underwater ground is proposed which explains the absence of a frequency dependence of the coefficient of backscattering of sound by the bottom in shallow-water regions. The model takes into account the anisotropy of inhomogeneities. The article gives a comparison of the experimental and theoretical angular dependences of the backscattering coefficient and there is found to be a good correspondence in the entire range of angles. Figures 1; references 8: 4 Russian, 4 Western.  
[92-5303]

UDC 551.463(260)

## PROGRAM FOR THE COLLECTION OF OPERATIONAL AND NONOPERATIONAL INFORMATION ON TEMPERATURE OF THE WATER SURFACE IN THE WORLD OCEAN (REVIEW OF FGGE MATERIALS)

Moscow OKEANOLOGIYA in Russian Vol 21, No 1, Jan-Feb 81 pp 150-153

ROMANOV, Yu. A., Institute of Oceanology, USSR Academy of Sciences, manuscript submitted 28 Jan 80

[Abstract] This review describes the program for the collection of observational data on temperature of the water surface during the FGGE period. Information is given on the accuracy and quantity of observational data on temperature of the water surface from ships, buoys and satellites. The flow of information in operational and nonoperational regimes is examined. The greatest volume of observations is from voluntary ships which make en route meteorological observations four times a day. There are now 7370 such ships, of which about 40% are usually at sea. These observations are distributed very nonuniformly over the earth, being concentrated for the most part in the middle latitudes in the northern part of the Atlantic and Pacific Oceans. Some information is received from six weather ships, and a small



quantity of information is received from scientific research ships. All this information is coded and transmitted by radio to 320 port radio stations and from there through the global telecommunications system to national meteorological centers. There these data are used for compiling operational weather maps after which they are reduced to magnetic tape and sent to the data center at Obolensk in the USSR. During the FAGE period considerable information on water surface temperature in the southern hemisphere between 20 and 65°S is being provided by 300 drifting buoys. Each 40-60 sec the buoys transmit signals which are received by the TIROS-N satellite. From the satellite these signals are transmitted through four ground tracking stations to the NOAA center in Maryland and from there are relayed to the Toulouse data processing center in France. There these parameters are converted into water surface temperatures, coded and through the global telecommunications system are routinely sent to the national meteorological centers. Two meteorological satellites give data on water surface temperature. The Nimitz and CMS satellites carry scanning radiometers and make measurements in the tropical zone 45°N-45°S with an accuracy of 0.1°C and a resolution of 5-7 km. The satellite signals are received by ground stations at Darmstadt and Tokyo. There they are converted into temperature values, coded and routinely transmitted to the national meteorological centers through the global telecommunications system. This is but an overview of the data collection system, which is considerably more complex. Figures 1; references: 3 Western.

[92-3803]

## TERRESTRIAL GEOPHYSICS

### UZBEK HYDROSEISMOLOGIST ON EARTHQUAKE RESEARCH

Moscow MOSCOW NEWS in English No 48 (Dec 7-14), 1980 p 10

[Article by Elparid Khodzhayev]

[Text] People in the Ukraine were warned in advance of an earthquake of force 4.5, although its epicenter was far off in the Tien Shan Mountains.

The Institute of Seismology of the Academy of Sciences of Uzbekistan has pioneered the study of the phenomena heralding earthquakes. Institute staff are able to forecast up to two-thirds of the underground tremors, making it possible to take timely safety measures.

"Unfortunately, we have not fully unravelled the enigma of the origin of earthquakes," said hydroseismology department head Abdumubdi Sultankhodzhayev, Corresponding Member of the Academy of Sciences of Uzbekistan. "But we can say when a shift of the earth's crust will occur, although we are not sure of its epicenter.

"Research and development at our Institute — established after the 1966 earthquake which destroyed Tashkent — proceeds along three main lines of study. First, the identification of the precursors of earthquakes and forecasting. Second, the drawing up of seismic zones for Uzbekistan. And third, the automation of seismic observation.

"The Institute has three geodynamic testing grounds, each something like a rough circle of 350-400 square kilometers. The instruments installed monitor the planet's tectonic activity. Besides, every region of the Republic has its forecasting stations which follow the changes in the earth. The Institute has developed a hydro-seismological method of studying the gas-chemical content of subterranean waters."

Q: Since you are one of those who made the discovery, can you speak in greater detail about it?

A: The subterranean hydrosphere — the area of spread of water in a liquid state in the earth's crust — extends down to 20-30 km. More than 80% of all the world's earthquakes originate at these depths. The pores and fissures of mountain rock, which makes up the larger part of the envelope of the earth's crust, are filled with water. Therefore, water should be viewed as a component of the environment of seismic processes, as geophysical studies have indicated. It was noted that quite

a while prior to the Tashkent earthquakes the helium and radon in the thermomineral water had noticeably increased. By mid-1965 it had risen to almost double the normal level, but had stabilized by that October. Then shortly before the earthquake we recorded a sharp drop in content.

Q: What happens in the earth's crust just before an underground tremor?

A: Energy slowly accumulates close to the epicenter of the imminent earthquake, the pressure increases and rock micropores are ruptured. This opens up the gates to the previously isolated inert gases and they are able to reach to subterranean waters in incredible quantities. This is why we have concluded that artesian waters should be regularly analysed. This is why we have set up the testing grounds and why we are building the forecasting stations. We have discovered important repetitive patterns, such as the fact that the helium concentration in subterranean waters increases by a factor of 10-12 and the radon concentration by a factor of 3-4 in the period preceding a strong underground tremor. The concentration of other gases, such as argon and fluorine, also increases. And the ratio of the isotope content of other elements changes.

Q: Is the hydrosismological method used elsewhere?

A: Yes, it has been adopted by scientists in the United States, Japan, France, Italy and Yugoslavia.

This method is not the only one. We are trying to find if there is a definite relationship between the changes of the magnetic field and electromagnetic pulses and earthquakes. Some findings indicate that there is a relationship. At the Institute we have an astrogodetic group which is using the astrophysical method to try and corroborate Wegener's hypothesis about the drift of continents, a hypothesis which is more than 50 years old. What we want to find out is this: if there is a drift, is it in any way related to the development of seismic processes?

Naturally, if the search for the phenomena heralding underground turbulences is to be successful, seismologists from different countries will have to work together.

[19]

CSO: 1852

## NEW METHOD FOR EARTHQUAKE PREDICTION

Kishinev SOVETSKAYA MOLDAVIYA in Russian 20 Jan 81 p 4

[Article by V. Ovcharov]

[Text] Soviet geochemists have discovered an unexpected effect which makes it possible to predict earthquakes. On the basis of experiments in the seismically active regions of Central Asia they have established a dependence between the concentration of mercury vapors entering the atmosphere from the earth's crust and mechanical stresses in its deep layers.

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"The way which led us to today's conclusion reminds me of a scientific detective story," said Yu. Stakheyev, senior scientific specialist at the space chemistry laboratory at the Geochemical Institute USSR Academy of Sciences. "Meteorites gave us the first hint for developing the idea. In the past they have been found to contain an exceedingly high mercury content. This fact, which is now known as the 'mercury paradox,' seemed especially surprising: indeed, in terrestrial rocks the quantity of this element is a thousand times less. But logically these values should be very close: we have assumed the mercury content in meteorites to be the mean cosmic value."

"We obtained still stranger results when proceeding to an analysis of lunar ground returned to the earth. It was found that its mercury content was still less than in terrestrial rocks."

"During work with lunar ground geochemists encountered an unexpected effect: it was found that upon contact with the earth's atmosphere the lunar samples rapidly absorb mercury from it. The thought arose: do meteorites behave in the same way? Do they absorb mercury from the air when they are stored in museum and laboratory collections? Meteorites are a convenient object for such investigations since the dates of their falling on our planet, finding and arrival at the museum are known. Such registry began 100-150 years ago. On the basis of investigations and statistics it was possible to detect a dependence of the mercury content in meteorites on the time of their presence on the earth. It was found that at the time of falling almost all the emissaries of space had an identical low mercury content."

"However, the following question remained open: why is the mercury content so low in terrestrial samples? And it was found that the main mass of mercury does not lie in the earth but continuously circulates. Arriving from the depths of the

planet, it passes through the rocks, enters the atmosphere, then is washed from it by rains, enters the rivers and then the oceans and ocean sediments. What occurs to it later is not entirely clear, but if one adheres to the continental drift hypothesis, later it can penetrate under the continental plates so that it undergoes the next natural cycle. During the lifetime of the planet this evidently has occurred more than once."

"At the same time it was established that the flux of mercury vapors changes with time. In particular, a 14-day periodicity was registered which we attributed to lunar tides. Indeed, tides exist not only in the ocean, but in the earth's crust as well. During the 'high' tide the earth's crust is slightly compressed, whereas during the 'ebb' tide it is additionally dilated. It was postulated that these periodic compressions and dilatations, in general negligible in comparison with the total pressure in the earth's crust and especially in the depths of the planet, exert an influence on the intensity of mercury fluxes. But if this is so, then the accumulating mechanical stresses in the crust must also exert an influence on changes in the flux of mercury vapors. Since the accumulation of stresses precedes an earthquake -- a jump-like release of stresses -- the registry of the flux of mercury vapors can be used for the early prediction of earthquakes."

"The hypothesis of the scientists was confirmed. In 1979 they carried out a series of experiments in Dushanbe, and in the past -- in Frunze. Using the atomic-absorption photometer created at the institute, making it possible to detect ultrasmall quantities of mercury, it was possible to measure its content at two levels: in the subsurface borehole water and directly in the gas flow from the crust. Seismic stations simultaneously registered the tremors. And here was the result: four days prior to the earthquake the mercury content as a rule clearly dropped and then increased."

"Researchers are not being hasty with their conclusions. The method which they have proposed for predicting earthquakes has proven to be 60-70% correct for the time being. In addition, the results were based on observations during those periods when the intensity of the underground tremors did not exceed two-three scale units. However, we are sure that the use of the discovered pattern, together with existing geophysical methods, in the immediate future will already make it possible to make predictions with a probable success of 70-80%."

"Such searching scientific thought led researchers from a study of seemingly remote cosmic mysteries to the discovery of new possibilities in the single-handed combat between man and terrestrial forces."

[77-5903]

5903

CSO: 1865

## MAGNETIC FIELD OBSERVATIONS IN ANTARCTICA

Moscow LENINSKOYE UTRAMIA in Russian 18 Jan 81 p 4

[Article by A. Anikhanyan]

[Abstract] Scientists of the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation have participated in all 25 Soviet Antarctic Expeditions. Antarctica is the site of the south geomagnetic pole, the place where the lines of force of the earth's magnetosphere, which is in active contact with cosmic plasma and the interplanetary magnetic field, converge. At the pole the magnetosphere is constantly in a disturbed state. This is registered by the sensors of 10 automatic magnetic variation stations that have been installed along the route from Mirny to the pole. The efforts of institute researchers have been directed to study of magnetograms registered by unmanned instruments which can operate for a year. Each magnetogram gives the magnetic field variations for the year at the particular place. It was established long ago that magnetic field data rapidly become out of date due to constant changes. No other field is characterized by such sharp variability. The earth's magnetosphere experiences changes in the course of a day and even an hour. That is why four expeditions of institute polar workers have installed stations in Antarctica at a distance of 150 km apart. The data which they have obtained will make it possible to understand the changes in disturbances from the geomagnetic pole to the auroral zone. On the next expedition polar specialists will seek out the magnetic recorders which have been exposed during the preceding year. When the sledge-tractor train locates the instruments the record is removed and new film is loaded, power source and electronic components are replaced. Experimental data from the last Soviet Antarctic expeditions are now being processed in the laboratory of the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation. These investigations are making it possible to compile more precise maps for cosmonauts and seamen, fliers and geologists.

[80-5303]



## DETERMINATION OF A CONTACT SURFACE FROM PROCESSING OF GRAVIMETRIC DATA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 1, 1981 pp 36-44

SHUL'MAN, I. I., USSR Petroleum Industry Ministry, All-Union Scientific Research Institute of Organization, Control and Economics of the Petroleum and Gas Industry, manuscript submitted 17 Apr 80

[Abstract] Methods for solving inverse problems in gravimetric prospecting based on an examination of hydrodynamic problems involved in determining the interface between two fluids were defined in earlier articles (V. L. Danilov, IZV. AN SSSR, FIZIKA ZEMLI, No 7, pp 43-53, 1978; V. L. Danilov and I. I. Shul'man, IZV. AN SSSR, FIZIKA ZEMLI, No 1, pp 94-104, 1980; DOKL. AN SSSR, Vol 250, No 1, pp 62-66, 1980). The results of solution of model examples cited in the latter two articles are evidence of the effectiveness of the proposed methods. This article represents a continuation of the author's earlier work and an application of the results. In particular, the defined procedures are applied to solution of the problem of determining a contact surface. Dissipative hydrodynamic processes in a porous medium are considered. Algorithms and finite-difference schemes are proposed for solution of the corresponding Cauchy problems. The article gives the results of solution of model problems further illustrating the effectiveness of the proposed methods and the possibility of using them in an investigation of petroleum- and gas-bearing structures on the basis of gravimetric data. Figures 4; references: 16 Russian. [86-5303]

UDC 550.837.6

## NUMERICAL INVESTIGATIONS OF THE RESOLUTION OF DEEP FAULTS BY THE MAGNETOTELLURIC SOUNDING METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 1, 1981 pp 45-54

DMITRIYEV, V. I. and MERESHCHIKOVA, E. A., Computation Center, Moscow State University, manuscript submitted 26 Mar 80

[Abstract] Magnetotelluric sounding is used extensively in exploratory geophysics and in deep geophysical investigations. The resolution of the MTS method has been used for the most part for stratified media and media containing a layer of variable thickness. However, it is of great interest to probe media containing deep faults. In theoretical investigations of the possibilities of the magnetotelluric and magnetovariation sounding methods applicable to the study of deep faults it is a convenience to use a model in the form of a three-layered medium containing a well-conducting inhomogeneity in the form of a narrow vertical insert (stratum). In this article the authors make numerical investigations of the dependence of impedance and the vertical component of the magnetic field on different parameters describing a fault model. It is shown that it is possible to determine the basic

parameters relative to which the magnetotelluric sounding method has an adequate resolution. Then it is shown that by computing the electromagnetic field in the described model it is possible to detect the influence exerted on the magnetotelluric field by deep inhomogeneities (faults), which constitute a vertical conducting stratum. The distorting influence of deep inhomogeneities on the magnetotelluric sounding curves is manifested for the most part at low frequencies. An exception is deep sections for which the sedimentary cover screens the field and the fault is traced on the impedance curves at high frequencies. Although the resolution of the MTS method is low in determining the extent of a deep fault, MTS data can be used in ascertaining the depth of plunging of a stratum distorted by a deep fault. Figures 5; references: 2 Russian.  
[84-5303]

#### MODELING OF THE RADIAL GRADIENT OF CONDUCTIVITY IN LOGGING PROBLEMS

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 8, Aug 80 pp 96-100

ANTONOV, Yu. N., and KRIVOPUTSKIY, V. S., Institute of Geology and Geophysics, Siberian Department, USSR Academy of Sciences, manuscript submitted 16 May 79

[Abstract] The penetration of a stratum-collector by the drilling of a borehole filled with mud on a water base can be accompanied by the penetration of filtrate into the stratum. With a different mineralization of the mud and stratum fluid the resistivity or conductivity of the stratum around the borehole changes as a result of the total or partial expulsion of the fluids in depth. In this case a zone of transition from the resistivity level in the scoured part of the stratum to its natural value is formed between the expelled fluid and the penetrating filtrate. The transition from one value to another can change smoothly and be approximated either by a straight line or a second-order curve with a different slope to the stratum strike. Such an approximation is evidently correct for homogeneous water-bearing or gas and petroleum-bearing collectors. However, in some cases the transition zone can be complicated by an anomalously increased conductivity due to the accumulation of highly mineralized stratum water in front of the penetrating filtrate front. If the permeability of the stratum is radially isotropic around the borehole there can be formation of an "annular" zone coaxial with the borehole. The radial anisotropy of permeability creates conditions for the appearance of zones of penetration of an ellipsoidal configuration around the borehole. In this article it is shown that for problems in electromagnetic logging, especially high-frequency induction isoparametric logging (IFILL), using frequencies up to 15 million Hz, it is desirable to investigate and validate the equivalence of models with a smooth transition zone and models in which the transition zone is represented by a cylindrically layered distribution of conductivity. Accordingly, for IFILL apparatus, based on measurement of the relative characteristics of the electromagnetic field of a vertical magnetic dipole, the investigation of the radial characteristics of probes and computation of models for interpretation of the results of measurements can be carried out on the basis of idealized cylindrically layered models. Figures 4, tables 3; references: 11 Russian.  
[52-5303]

## STATE GEODETIC SERVICE IN THE TENTH FIVE-YEAR PLAN

Moscow ZEMLYA I VELENENAYA in Russian No 1, Jan-Feb 81 pp 8-10

KASHIN, L. A., candidate of technical sciences, first deputy head of the Main Administration of Geodesy and Cartography

[Abstract] With respect to the astrogeodetic (1st-order) network, in the 10th Five-Year Plan work continued on further development of the network by the continuous construction of 2d-order triangulation nets with an accuracy in measuring angles of about 0.7-0.9" with the determination of astronomical latitudes, longitudes and azimuths and measurement of distances with pulsed-light range finders under a 1st-order program. Preparations were begun for a new general adjustment of the astrogeodetic net. In 1977 a new program was developed for the USSR leveling net up to 1990. In the 10th Five-Year Plan work was completed on adjustment of the USSR leveling net. A unified system of elevations now extends over the entire territory of the country. For the first time geodesists have data on the differences in levels of all the seas in the USSR. With respect to study of deformations of the earth's crust, in many regions of the country there is now a network of geodynamic polygons. The Main Administration of Geodesy and Cartography takes an active part in work for the prediction of earthquakes. Over considerable areas (polygons), knowing crustal deformations, it is now possible to solve different scientific and technical problems and carry out seismic regionalization. Data on deformations are necessary in theoretical computations of the forces accumulating in the earth's interior and in the last analysis causing earthquakes. Geodetic measurements have made it possible to detect relatively small deformations (several millimeters per year), data which is extremely necessary in microseismic regionalization of Alma-Ata, Tashkent and other cities. With respect to surveys from space, these have come into wide use in the mapping of inaccessible regions in the country and Antarctica. Space surveys have now been employed not only in the compilation of small-scale topographic maps, but also special maps characterizing the state of agricultural areas, forests, shelf zones, geological structures and ocean currents. In mapping the shelf the USSR has now adopted a transverse-cylindrical Gauss projection which makes it possible to project a spherical surface onto a plane with maximum similarity. The principal scales are 1:25,000 and 1:50,000 with the representation of relief by contours, not isobaths. The most effective tool being used in mapping of the shelf is a side-view sonar developed at the Central Scientific Research Institute of Geodesy, Aerial Mapping and Cartography. In the field of large-scale topographic surveying, much work has been done in mapping at scales of 1:2,000, 1:5,000 and 1:10,000. The principal methods used in this work are polygonometry and pulsed-light rangefinding. Figures 4. (71-5303)

## PRIMARY OBJECTS AND METHODS FOR LOCATING GAS HYDRATE DEPOSITS IN THE SEDIMENTS OF SEAS SURROUNDING THE USSR

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 11, 1980 pp 3-10

TROFIMUK, A. A., CHERSKIY, N. V., TSAREV, V. P. and DOROVIKOV, Yu. V., Institute of Geology and Geophysics, manuscript submitted 22 Jan 80

[Abstract] In this article it is shown that the extractable supplies of gas from gas hydrate deposits in sea sediments of Far Eastern and Southern seas can amount to several thousand trillion cubic meters. The work complex for locating and exploring gas hydrate deposits includes deep-water reference and parametric drilling with removal of a core by hermetic corers, measurement of its gas factor and the carrying out of laboratory investigations of the elastic properties of sediments. The principal methods for probing the top and bottom of gas hydrate strata and also evaluating the degree of their saturation with hydrates are geoaoustic. In profiling systems it is proposed that use be made of a complex of sources with working frequencies of 10-12, 3-4 KHz and 100-300 Hz. In the working of geoaoustic profiles provision is made for the systematic sampling of sediments by corers for depths of 10-12 m from the bottom surface. It is shown that gas hydrates have been discovered on millions of kilometers of profiles in the Atlantic, Pacific and Indian Oceans. A good area for perfecting methods for discriminating the top of the zone of hydrate formation would be Lake Baykal and the Black Sea. The boundary of the zone of hydrate formation (top of the zone of methane generation) in these water bodies is at a distance from tens of centimeters to 3-5 m from the bottom surface where the water depths are from 600 to 2,000 m. The exploitation of marine gas hydrate deposits is possible at the modern level of development of technology with the use of both known, somewhat modified technology for the development of gas deposits, such as the heating of the stratum with thermal waters or with intrastratum combustion and with fundamentally new technology with the use of systems for deep-water exploitation of placers. Figures 3; references 20: 8 Russian, 12 Western. [67-5303]

## INVESTIGATION OF A SIMPLIFIED MODIFICATION OF A TRENCH SOURCE OF TRANSVERSE WAVES

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 8, Aug 80 pp 69-78

PUZYREV, N. N., TRIGUBOV, A. V., KULIKOV, V. A., ZHDANOV, S. M., NEDASHKOVSKIY, I. Yu., ADAMOVICH, B. P., VAYSEROV, N. A. and VOTSALEVSKIY, Z. S., Institute of Geology and Geophysics, Siberian Department USSR Academy of Sciences and Gornftegeofizika, manuscript submitted 17 Jan 80]

[Abstract] During recent years much work has been done on new explosive sources of transverse waves. The use of a barrier source (special type of trench) with lines of shot holes in the permafrost areas of the West Siberian Plain has yielded seismic data obtained by the transverse waves method in places of occurrence of quick-sands where the ground water level is high. The barrier method permits a higher degree of mechanization of excavation work than the original simple trench method. Both methods have been inefficient due to the lack of trench excavation equipment.



The article describes trenchers of the plow or knife type which have been devised for solving this problem. Particular attention is given to the PDSh-1 trencher, which is illustrated. A special problem is the design and spacing of the knives, the objective being the creation of a more even outer wall of the trench. The degree of loosening of the ground is increased with a second pass. It is easy to produce a trench with a depth of 60-70 cm with uneven subvertical side walls. The slope of the side walls to the vertical is equal approximately to the angle of internal friction of the ground. Its greatest value (30°) is characteristic for unconsolidated sandy-clayey ground and its minimum value is characteristic for viscous clayey and silty ground. The authors give particular attention to clarification of the dependence of the seismic effect of excitation of transverse (SH) waves on the slope of the side walls of the trench and the distance of the charge from the walls. The dependence of the radiation of transverse waves on the parameters of the improved trench source variant is analyzed in detail. This is followed by a comparison of the effectiveness of sources of different types.

[53-5303]

UDC 528.113

#### ERROR IN POINT POSITION

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 2, Feb 81 pp 14-16

KOUGIYA, V. A.

[Abstract] In an article by P. P. Skorodumov entitled "Evaluation of the Accuracy in Determining the Position of Points in Geodetic Control" (GEODEZIYA I KARTOGRAFIYA, No 2, pp 23-26, 1980) the mathematical substantiation given by V. A. Kougiya (GEODEZIYA I KARTOGRAFIYA, No 11, pp 12-15, 1978) for evaluating the position of a point, computed using the formula

$$M = \sqrt{\sigma_x^2 + \sigma_y^2},$$

is demonstrated by two other methods. However, some points in the Skorodumov article are erroneous and this article points them out one by one and shows why they are incorrect. For example, in computing the mean square error in the position of a point from the elements of parametric correction equations, it is necessary, despite the contention of Skorodumov, to take into account not only the mean square errors, but also the correlation moment. The statement that the inclusion of repeating or systematic errors in the correlation coefficient is inadmissible is also incorrect. Despite the assertion of the author, the total errors in measurements cause changes in the correlation matrix of the coordinates of the point to be determined, and therefore in the form of the ellipse of errors. Elsewhere, it is untrue that the ellipse of errors corresponds to a unique, and therefore "true" correlation coefficient. These are but a few of the errors and inaccuracies and therefore the Skorodumov article must be accordingly dealt with bearing this in mind.

[115-5303]

## REVIEW OF ADVANCES IN THE EARTH SCIENCES

Moscow ZEMLYA I VNELENNAYA in Russian No 1, Jan-Feb 81 pp 2-7

BOKOLOV, B. S., academician, and BREKHOVSKIKH, L. M., academician

[Abstract] Academicians Sokolov and Brekhovskikh give a very general review of advances in the earth sciences in the Soviet Union during recent years. In the geological sciences significant work has been done in the field of geochronology and correlation of geological events and processes, in the fields of lithology, geotectonics and the geology of petroleum and gas. In the field of geophysical research, considerable advances have been made in the study of the core, lithosphere, asthenospheric layer, gravitational field, recent movements of the earth's crust, physics of earthquake foci, thermal regime of the planet and space chemistry. In the field of oceanography the most important work has been done in the study of eddy formations of a synoptic scale, fine structure of ocean waters, collection of oceanographic information by oceanographic satellite, contending with contamination of the oceans and seas by petroleum products, geology of the floor of the world ocean and biological investigations. In studies of atmospheric physics and meteorology Soviet scientists have scored rather outstanding successes in understanding global changes in climate and formulation of the principles of its theory, development of methods for remote determination of atmospheric parameters, formulation of a theory of similarity for general circulation of planetary atmospheres and investigation of gas impurities in the entire thickness of the atmosphere. Soviet geographers have developed rational ways in which to use natural resources and preserve the environment, have expanded work in such areas as evaluation of water resources. [The article devotes about a paragraph to an evaluation of work in each of these fields.] Figures 7.

[71-5303]

UDC 550.834.32

## WAYS TO DEVELOP DEEP SEISMIC INVESTIGATIONS

Moscow SOVETSKAYA GEOLOGIYA in Russian No 11, Nov 80 pp 108-115

REZANOV, I. A.

[Abstract] After reviewing the strengths and weaknesses of deep seismic sounding work in the USSR during the last 20 years, the author examines the needs for further development in this field and the problems which must be solved by deep sounding in the coming years. The problems which sounding must solve include the following. 1) Investigation of the structure of deep layers for the purpose of interpreting the patterns of development and formulation of a general theory of the earth, including investigation of the earth's crust in seismically dangerous zones by seismic methods. 2) Study of deep petroleum- and gas-bearing basins for the purpose of locating and exploring fuel deposits. 3) Interpretation of structure of the crystalline basement of platform and folded regions for the purpose of predicting and finding solid fuels. All this requires an investigation of the general patterns of structure and development of the deep layers, involving interpretation not only of the



crust, but also the upper mantle, and accordingly, a considerable increase in the effective depth of the deep seismic sounding method. Solution of such problems in many cases requires deep seismic sounding profiles with a length of 500 km or more on the land and 200-300 km in the oceans. In the coming years a large volume of seismic investigations must be made for a detailed study of the crust in seismically active zones. Use of the DSS method in the prediction of earthquakes can result in major successes, but this will require a considerable increase in the detail of observations. One of the objectives should be creation of a three-dimensional seismic model of the medium. Particular attention should be given to the epicentral zones of past and hypothetical earthquakes. A second direction in regional seismic work is study of the deep structure of petroleum- and gas-bearing depressions. A third direction is the interpretation of the internal structure of shields of ancient platforms and folded zones, which contain deposits of virtually all types of mineral raw material. Investigation of the crust of the shields by seismic methods in the USSR lags greatly with respect to both volume and detail of work relative to study of depressions. Due to inadequate study of the deep structure of ancient shields (Baltic, Ukrainian, Anabar, Aldan) the Soviet mining industry is extracting fewer minerals from the deep layers than is true of deposits in the Canadian, African and Australian shields. The study of the upper 10-15 km of the consolidated crust of anticlinoria and shields is a problem of primary importance. It must be carried out by the implementation of special seismic work along profiles in combination with the drilling of deep and superdeep boreholes. The primary objects for seismic investigations, other than petroleum and gas basins, should be the potentially ore-bearing regions of the shields and folded zones, and also zones of high seismic danger. References: 9 Russian.  
[59-5303]

UDC 550.834

# 'STATISTICAL WAVE TRACKING' PROGRAMMED INTERPRETATION COMPLEX

Moscow IZVESTIYA VUZov: GEOLOGIYA I RAZVEDKA in Russian No 11, Nov 80 pp 109-114

BOGANIK, G. N. and NEMETSKAYA, Z. A., Moscow Geological Prospecting Institute

[Abstract] The "Statistical Wave Tracking" programmed interpretation complex is an application of the algorithm developed earlier by the author (IZV. VUZov: GEOL. I RAZV., No 11, 1977). The purpose of this complex is an objective quantitative analysis of the kinematic parameters of waves on the basis of data from multiple seismic profiling for the purpose of interpretation of a complex wave pattern. The initial data are the kinematic parameters read from records obtained by the adjustable directional reception method. The profiling system must include direct return observations and ensure obtaining adjustable directional reception bases located at adequately great distances from one another. The complex and its components are fully described. Use of the complex ensures a statistical analysis of the kinematic parameters of the wave field which yields increased quantitative information on field structures, which favors a more complete and sounder interpretation of complex time sections. Figures 1, tables 2; references: 3 Russian.  
[45-5303]

## ACOUSTIC EMISSION AND ELECTROMAGNETIC RADIATION DURING UNIAXIAL COMPRESSION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 4, 1980 pp 821-824

GONCHAROV, A. I., KORYAVOV, V. P., KUZNETSOV, V. M., LIBIN, V. Ya., LIVSHITS, I. D., SIDMERCHAN, A. A. and POMICHEV, A. G., Institute of Physics of the Earth, manuscript submitted 4 Aug 80

[Abstract] New results of measurements of the natural radiation of electromagnetic waves have recently been published. These studies indicate the possibility of the existence of radiowave precursors of earthquakes. The nature of the correlation between seismic activity and natural electromagnetic radiation of the earth has remained unclear. It can be postulated that during the fracturing of rocks it may be possible to observe electromagnetic and acoustic pulses having a common source. One of the reasons for the lack of information on the correlation between these phenomena is that it is difficult to organize mechanical tests with simultaneous registry of electromagnetic radiation, seismoacoustic emission and other fracturing parameters. The authors carried out simple compression tests using a press with a force of 50,000 tons. The samples were concrete blocks measuring  $0.55 \times 0.55 \times 0.65$  m. The registry of seismoacoustic energy was simultaneous in six independent channels with different amplification factors and frequency characteristics. Measurements of electromagnetic radiation were with instrumentation consisting of a HF amplifier, detector and LF amplifier. An oscillograph registered the envelopes of signals in the range  $\sim 0.8 \cdot 10^6$  Hz. Measurements of both electromagnetic radiation and seismoacoustic energy were made at the same time scale beginning at the moment of application of the load, ending with sample destruction. The duration of each test was about 10 minutes. It was found that the correlation between the two records was 0.96. The record of electromagnetic radiation exhibited a period of "calm" preceding destruction which resembles the period of calm of certain parameters of geophysical fields prior to an earthquake. Figures 1; references: 9 Russian.

[39-3303]

UDC 550.341

## METHOD AND RESULTS OF ANALYSIS OF SPATIAL-TEMPORAL FIELD OF SEISMIC ACTIVITY

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 5, 1980 pp 1073-1075

ZHURAVLEV, V. I., Institute of Physics of the Earth, manuscript submitted 28 Jul 80

[Abstract] An adequately complete description of the seismic regime requires use of more than such an integral characteristic as the mean density of epicenters; it is also necessary to introduce parameters determining the degree of uniformity of the distribution of seismic activity, its anisotropy and spatial orientation. For this purpose the author uses such characteristics of distributions as moments of different orders which are used in investigating spatial and temporal variations of the field of seismic activity in the Garm region of the Tajik SSR.

The center of gravity and moment of inertia were selected as characteristics of the field of hypocenters of earthquakes in a particular volume of the medium. These parameters characterize the orientation and form of spatial distribution of seismic activity. The region selected for study was at the center of Peter I Range, where between 1973 and 1979 there were several earthquakes with an energy class  $8 \times 11$ . Earthquakes within a vertical cylinder with a radius of 15 km and a height of 30 km were considered. The materials presented here indicate that the spatial distribution of seismic activity becomes unstable prior to strong earthquakes. It is shown that the approach presented here makes it possible to describe the seismic regime using analytical methods. Figures 3; references: 4 Russian. [33-5303]

UDC 550.34

# POSSIBILITY OF RESTORING MOVEMENT IN THE FOCUS OF A DEEP EARTHQUAKE FROM THE FIELD OF BODY WAVES IN THE DISTANT ZONE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 4, 1980 pp 824-828

PAVLOV, V. M. and GUSEV, A. O., Volcanology Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Petropavlovsk-Kamchatskiy, manuscript submitted 8 Jul 80

[Abstract] The authors examine the following idealized formulation of the problem of restoring movements in the earthquake focus on the basis of the field of body waves. The earthquake focus, described kinematically as rupturing along some smooth surface  $\Sigma$  with the normal  $n_i$  and a relative displacement of the sides  $B_i(x, t)$ ,  $i = 1, 2, 3$ , is situated in an unbounded linearly elastic isotropic homogeneous medium. The origin of the Cartesian system  $x_i$ ,  $i = 1, 2, 3$  is assumed to lie on  $\Sigma$  and the origin of time  $t$  reckoning is assumed to coincide with the origin of movements in the focus. The process of focal movement is finite in time and occupies a limited spatial region with the characteristic dimension  $D$  and therefore the selected vector function  $B_i \partial B_i / \partial t$  is assumed to be finite relative to  $x_i$  and  $t$ . Then within the framework of this focal model it is assumed that a whole series of conditions are satisfied. With this complex formulation of the problem it is shown that the stable determination of  $B_{\text{normalized}}(x, t)$  is in reality impossible, but this does not preclude stable determination of the large-scale characteristics of focal movement. Specifically, if the low-frequency part of the spectrum is known, as well as the geometric dimensions and duration of the source, it is possible to determine a function which represents the large-scale details of movement at the source. References: 4 Russian, 3 Western. [39-5303]

## RESULTS OF MULTISIDED GEOPHYSICAL STUDY OF THE SOUTHWESTERN MARGIN OF THE EAST EUROPEAN PLATFORM

Kiev GEOLOGICHESKIY ZHURNAL in Russian Vol 40, No 5, 1980 pp 38-47

FIL'SHTINSKIY, L. Ye., RASPOPOVA, M. G., GLUBHKO, V. V., VISHNYAKOV, I. B., Ukrainian Scientific Research Geological Prospecting Institute, Ukrainian Scientific Research Institute of the Gas Industry and L'viv State University, manuscript submitted 29 Jan 80

[Abstract] The solution of the problem of tectonics of the southwestern margin of the East European Platform in many respects is dependent on the extent to which it is possible to clarify the deep structure of adjacent areas and especially complexes making up the folded basement. Accordingly, the authors have reviewed and interpreted the data and literature on this subject and the methods employed in interpreting it. Particular attention is given to the following: generalization and refinement of the physical model; reinterpretation of data collected by the refracted waves method; reinterpretation of data obtained by the regulated directional reception method; compilation of a structural model of sedimentary complexes; quantitative analysis of gravity anomalies; quantitative analysis of magnetic anomalies; joint interpretation of geophysical data. It is shown that integration of all these materials makes it possible to define a transition region which can be differentiated at the Riphean-Cambrian level in whose structure the elements of tectonics peculiar to both the old platform and its geosynclinal framework are closely interwoven. It is suggested that in regionalizing the margin of the East European Platform it is necessary to differentiate sections with an intermediate structural complex between the cover and the basement, including them in the make-up of either the old or young platform in dependence on the nature of their activation and predominant type of dislocations. Within the limits of the transition region in the western part of the Ukrainian SSR the boundary of the East European Platform is determined by Hercynian structures. Figures 4; references: 9 Russian. [60-5303]

UDC 538.3:550.346

## RADIOEMISSION ACCOMPANYING BRITTLE DESTRUCTION OF DIELECTRICS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 4, 1981 pp 824-826

FEL'DMAN, N. Ye. and KHATIASHVILI, N. G., Institute of Cybernetics and Geophysics, Institute Georgian Academy of Sciences, manuscript submitted 13 Oct 80

[Abstract] It is shown that the formation of fractures in solids and discontinuities in fluids should be accompanied by the generation of electromagnetic radiation, most of which is concentrated in the range  $10^4$ - $10^9$  Hz. Such effects of generation of electromagnetic radiation can make a contribution to the radio-emission arising during earthquakes. The generation of electromagnetic radiation



occurs during the motion of charges relative to a fixed medium, during periodic oscillations of dipole and other moments in the medium (piezoeffect) and during movements of parts of the medium with separated fixed charges. During brittle destruction the most important role evidently must be played by mechanisms of the latter type. These mechanisms must be associated with electrification of the walls of the fractures and the dynamics of their movement. However, there can be another electrification mechanism caused by random breaks of interatomic and interionic bonds with an increase in the fracture, leading to the formation of a charge mosaic on the fracture surface, that is, a fluctuating charge. The appearance of a charge mosaic on the sides of the fractures leads to the generation of electromagnetic radiation due to the appearance of electric currents during the relaxation of charges, discharge between individual parts or sides of fractures, and also the nonuniform movement of the charge mosaic in the initial stage of formation and separation of microfractures. The latter two effects have not been discussed in the literature and constitute the subject of this article. In all the considered cases the static field of the fracture can considerably increase the relaxation time of the charges, that is, increase the duration of generation of electromagnetic radiation. The effects described here in detail can introduce a definite contribution to the radiation associated with the processes of preparation for and occurrence of earthquakes. References 14: 12 Russian, 2 Western. [75-5303]

UDC 550.341

#### SPATIAL PERIODICITY OF SEISMIC ACTIVITY IN THE GARM REGION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 1, 1980 pp 71-73

ZHURAVLEV, V. I., Institute of Physics of the Earth, USSR Academy of Sciences, manuscript submitted 30 Jun 80

[Abstract] One of the methods for estimating the predominant size of inhomogeneities in the earth's crust is the field of epicenters of earthquakes in a seismically active region. The concentration of earthquake foci in individual parts of the crust separated by zones of weak seismicity gives a general idea concerning the scales of inhomogeneities. However, an integral description of the distribution of blocks by sizes independently of their location is of equal interest. A quite convenient approach for the description of the statistical distributions of inhomogeneities by scales is the Fourier transform method used for similar purposes, for example, in the study of turbulence processes. Accordingly, the author made an attempt to study the distribution of the size of horizontal inhomogeneities of the earth's crust by the Fourier transform method. The investigated area was the Garm region. The analysis was made using a catalogue of earthquakes for the Garm region between 1955 and 1979. This gave data on about 53,000 events. The extent of the polygon within which the events were selected was about  $10^4$  km<sup>2</sup>. The accuracy in determining the horizontal coordinates of the hypocenter of an individual event is 1.5 km in the inner part of the polygon and decreases toward the edges. A study was made of blocks with a dimension  $L$  from 1 to 30 km. The computations were made in several stages in time intervals of about 10 years. The resulting function  $\Phi$

was determined as the sum of the intermediate values. It was found that near large  $L$  the distribution of scales was close to isotropic. The first  $\Phi$  maximum is characterized with  $L_x = 19$  km and  $L_y = 26$  km; with close  $L_x$  and  $L_y$  values the values of the spectral function are not much less. Thus, large blocks have different sizes and in form are close to isotropic. With lesser  $L_x$  and  $L_y$  values the distribution becomes sharply nonisotropic. There is a predominant dimension in a N-S direction equal to  $L_x = 15$  km, greatly blurred in an E-W direction. The presence of these blocks reflects the near-latitudinal strike of the principal geological structures of the Garm polygon. Local inhomogeneities of a near-meridional direction are characterized by the presence of a maximum of the spectral function at  $L_x = 6$  km and  $L_y = 20$  km. The distribution of small-scale blocks by size is close to random. Horizontal inhomogeneities with a dimension less than 10 km have a lifetime less than 10 years. Large blocks are stable in time. The proposed method makes possible a rigorously formalized analysis of horizontal inhomogeneities of the earth's crust in tectonically active regions. Figures 1; references: 7 Russian, [72-5303]



UDC 551.521.14

LIGHT REFLECTION BY A HORIZONTALLY INHOMOGENEOUS CLOUD WITH ILLUMINATION BY SUN

Moscow IZVETIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, 1981 pp 27-36

ROMANOVA, L. M. and TARABUEHINA, I. R., Institute of Atmospheric Physics, USSR Academy of Sciences, manuscript submitted 3 Dec 79, resubmitted after revision 6 Mar 80)

[Abstract] The authors have solved the problem of reflection of sunlight by a horizontally inhomogeneous semi-infinite cloud with isotropic scattering. The dependence of the scattering coefficient on the horizontal coordinate is described by the formula  $\sigma(x) = \sigma_0(1 + \epsilon \cos \omega x)$ , containing a minimum number of parameters. The absorption coefficient  $\alpha$  and the scattering function are considered constant. Equations are used for the spatial amplitudes of the scattering functions obtained applying invariance principles. The solution is represented in the form of a series in  $\epsilon$  and  $N = \omega/(\sigma_0 + \alpha)$ . The coefficients of this series are found by numerical solution of the corresponding integral equations with values of the probability of survival of a quantum, related to  $\sigma_0$ , equal to  $\Lambda = 0.999; 0.99; 0.95; 0.9(0.1); 0.5; 0.3$ . Data are given for the fluxes and intensities of reflected light with an accuracy to terms of the order of  $\epsilon^2$ . Allowance for these terms is evidently adequate for geophysical applications. It was found that with  $\Lambda < 1$  the horizontally averaged albedo and intensity of reflected light are less than the albedo and corresponding intensity of a homogeneous cloud with  $\sigma = \sigma_0$ . With  $\Lambda \rightarrow 1$  the reflection by an inhomogeneous semi-infinite cloud approaches reflection by a homogeneous cloud. Figures 3, tables 2; references 4; 3 Russian, 1 Western.

[86-5303]

USE OF SMOOTHING SPLINES FOR RESTORING THE PROFILE OF THE  $H_2O$  MOLECULAR ABSORPTION COEFFICIENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKRANA in Russian Vol 17, No 2, Feb 81 pp 175-181

VOSKROBOYNIKOV, Yu. Ye. and NITSEL', A. A., Institute of Thermophysics and Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, manuscript submitted 23 Feb 79, resubmitted after revision 13 Mar 79

[Abstract] Smoothing spline functions are used for restoring the profile of the  $H_2O$  molecular absorption coefficient from lidar measurements when employing the differential absorption method. An algorithm is given for choice of the smoothing parameter  $\gamma$ . The stability of the proposed method is analyzed in a numerical example. The authors show that the proposed method for computing the absorption coefficient  $\alpha(R)$  by differentiation of a smoothing spline, like the method based on obtaining a regularized solution of the Ivanenko-Marichev equation, is a stable method for interpreting data obtained by the differential absorption method and makes possible successful use of a lidar as a tool for sounding the profile of the water vapor concentration in the atmosphere. However, the proposed method requires a less-or volume of the computer operational memory for storage of the initial data. It is also speedier than the Ivanenko-Marichev method for computing  $\alpha(R)$  through a regularized solution. The new method is free of discretization errors which can considerably increase the error of the solution. Figures 1; references 21: 18 Russian, 3 Western.

[118-5303]

UDC 551.510.53

## LIDAR INVESTIGATIONS OF THE STRATOSPHERE AT THE MOUNTAIN OBSERVATORY IN TURKMENIA

Ashtikhab IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNIЧЕСКИХ, INЖИНИЕРСКИХ I GEOLOGICHESKIKH NAUK in Russian No 1, 1981 pp 32-40

LACUTIN, N. F., OVEZGEL'DYEV, O., KHANBERDYEV, A., BERKELIYEV, H., HUSTETSOV, S. F., MEL'NIKOV, V. Ye., MUKHAMMEDIYAZAROV, S. and KURBAJIMURADOV, E., Physical-Technical Institute, Turkmen Academy of Sciences, manuscript submitted 3 Jul 80

[Abstract] Multiaided investigations of the middle atmosphere are being carried out under a program of scientific and technical cooperation between the Physico-Technical Institute Turkmen Academy of Sciences and the Khar'kov Institute of Radioelectronics. The article describes some of the work carried out in the laboratories of the Turkmen Institute, emphasizing the development of photoelectronic and radio-physical methods for geophysical observations, using ionospheric scattering, meteor phenomena, twilight and night airglow of impurities in the upper atmosphere. The combination of available experience, existing instrumentation, other facilities and special astroclimatic conditions in Turkmenia has led to the successful or-

organization of a lidar station for sounding mesospheric impurities. The theory and problems involved in lidar measurements are reviewed. The lidar apparatus installed in the "Night Airglow" laboratory is a sounding station operating in the optical range; Figure 2 is a block diagram of the apparatus with 17 components identified. This diagram serves as a basis for a discussion of this particular outfit. During October 1979 specialists carried out installation, adjustment and calibration of the lidar on the grounds of the astronomical observatory at Vannovskoye village. Preliminary experiments with lidar sounding were carried out in the epoch of the Geminids from 8 to 15 December 1979. The altitude of molecular scattering of laser signals is dependent on time accumulation and extends to 30-50 km. Fluctuations of atmospheric density characteristic for the middle latitudes are characteristic. Individual soundings clearly reveal dynamic aerosol layers at an altitude of approximately 7 km, 12 km, having a global character. In the region of the stratopause there is an aerosol layer which hypothetically has an anthropogenic origin. At the end of the Geminids meteor stream there was considerable aerosol scattering in the altitude range 30-80 km. The aerosol scattering exceeded the background level by a factor of 3-5 with a maximum in the regions 40 km and 60 km. This was the period of the maximum number of radio and optical meteors. Other lidar measurements were made in the summer of 1980. These revealed that in addition to the aerosol maxima observed at altitudes below 70-80 km there is a clearly expressed sodium layer in the atmosphere in the range 90-100 km. In the future the regular registry of resonance scattering from atmospheric sodium particles by means of a lidar system will make it possible to solve a number of important problems in physics of the middle atmosphere. Figures 3; references 25; 17 Russian, 8 Western.  
[112-5303]

UIC 551.501.8

#### COMPUTATION OF VOLUME COEFFICIENTS OF LIGHT ATTENUATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 968-973

KUGEYKO, N. M., BELOBROVSK, V. I., ASHKINADZE, D. A. and SERGEYEV, N. M., Belorussian State University, manuscript submitted 16 Apr 79

[Abstract] At the present time there is no generally accepted correct method for computing the volume coefficient of light attenuation on the basis of the results of single-frequency sounding. The collected data on the coefficient  $\hat{A}_L(x)$  are difficult to interpret because the sounding equation contains three unknowns and cannot be solved without making certain assumptions or having a priori information concerning the relationship of these characteristics and this considerably lessens the reliability of the results. The asymptotic signal method described by V. A. Kovalev, et al. (TRUDY OGO, No 312, 128-133, 1972) has definite advantages since it does not require assumptions concerning the structure and nature of the scattering particles, makes possible quite simple elimination of the influence of instrumental errors and substantially lessens multiple scattering noise. However, due to the finite extent of the medium or due to the limited response of the photodetector in the case of sounding of real media there is a substantial difference in the

computed and real volume coefficients of light attenuation, especially at the end of the sounding path (so-called "edge effect"), as explained here in detail. The application of the method for analytical evaluation of an asymptotic signal proposed by B. V. Kaul', et al. (VOPROSY DISTANTSIONNOGO ZONDIROVANIYA ATMOSFERY, Izv. 3-11, 1975) makes it possible to eliminate the influence of the "edge effect" on the accuracy of the restored  $\beta_L(z)$  values, but this requires use of a standard point to which the transparency value  $T(z)$ , obtained by lidar or parallel methods, is known. Accordingly, the authors have developed a method for eliminating the "edge" effect on the accuracy in restoring  $\beta_L(z)$  for paths of finite extent without these additional measurements of transparency to a standard point for single- and multilayered media. It is shown that the proposed method substantially increases the accuracy in restoring the  $\beta_L(z)$  profile, as is evidenced by a comparison with other known methods for determining  $\beta_L(z)$  and an analysis of the errors in determining  $\beta_L(z)$ . Figures 4; references: 4 Russian. [62-5303]

UDC 551.521.3

#### ALLOWANCE FOR THE AEROSOL EFFECT IN RADIATIVE HEAT EXCHANGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, Jan 81 pp 18-26

TARASOVA, T. A. and FEYDEL'SON, Ye. M., Institute of Physics of the Atmosphere, USSR Academy of Sciences, manuscript submitted 26 Jun 79, resubmitted after revision 14 May 80

[Abstract] In numerical models of general circulation of the atmosphere the radiation effect of aerosol is either not taken into account at all or is assumed to be some mean. Such an approach is inapplicable, for example, to the theory of climate in which it is important to take into account the influence of increasing aerosol contamination of the atmosphere. In this article an attempt is made to create a very simple aerosol model which allows allowance for a change in the aerosol composition for inclusion in an overall model of global atmospheric energy. The model is based on an evaluation of the sensitivity of atmospheric albedo to a series of aerosol parameters: real and fictitious parts of the refractive index, median radius and half-width of the distribution of particle sizes. For evaluating the thermal effect of aerosol the authors propose a simple model with two input parameters:  $S_0$  -- the total number of aerosol particles per unit volume of air and  $N_{org}/N_{back}$  -- the excess of the number of absorbing particles or organic particles, of industrial smog, above the background level. Figures 4, tables 4; references 21: 10 Russian, 11 Western. [86-5303]

## ONE-PARAMETER MODEL OF NEAR-SURFACE AEROSOL

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 1, 1981 pp 39-49

GORCHAKOV, G. I., YEMILINKO, A. S. and SVIRIDENKOV, M. A., Institute of Physics of Atmosphere, USSR Academy of Sciences, manuscript submitted 29 Nov 77, resubmitted after revision 15 May 80

[Abstract] It is shown that models of the submicron aerosol fraction based on log-normal distributions agree satisfactorily with the results of measurements of the light scattering matrices. A method has been developed for solving the inverse light scattering problem in the approximation of one fraction with a log-normal distribution. The method of microphysical extrapolation of a statistical model of optical characteristics was used in formulating a one-parameter model of the submicron fraction of atmospheric aerosol. The meteorological range of visibility is the input parameter of the model. Empirical formulas were derived for the dependences on the scattering coefficient, refraction coefficient, median size and concentration of particles and also the near-surface aerosol space factor. It was also possible to ascertain the dependence of the volume of dry aerosol matter on the meteorological range of visibility. The model proposed in this article was developed on the basis of measurements of optical characteristics in the Moscow region during autumn, but since the estimates given for the microstructural parameters and the refraction coefficient for the submicron fraction agree with the results obtained in other studies by other methods, it can be expected that there will also be satisfactory agreement for other conditions, provided that the optical characteristics are determined by the submicron aerosol fraction. Figures 3, tables 2; references 20; 13 Russian, 7 Western.  
[86-5303]

## ABSORPTION OF INFRARED RADIATION BY DIFFERENT ATMOSPHERIC AEROSOL FRACTIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, 1980 pp 907-916

ANDREYEV, S. D. and IVLEV, L. S., Leningrad State University, manuscript submitted 2 Feb 79, resubmitted after revision 20 Oct 79

[Abstract] The transmission spectra of samples of atmospheric aerosols in the spectral region 2-15  $\mu\text{m}$  are investigated. It was found that the principal role in the absorption of IR radiation by atmospheric aerosol is played by mineral matter, both soluble (sulfates, carbonates, cyanides, etc.), and insoluble (silicates, aluminum oxide). The role of aerosol particles consisting of organic substances in the absorption of IR radiation is small and in this sense a model of optical characteristics of aerosols which takes into account only the mineral components of aerosols



is satisfactory. The role of organic substances can be substantial under the specific conditions of a pure, slightly turbid atmosphere and in attempts to take into account and describe the process of interaction between aerosol and atmospheric water vapor. Particles of atmospheric aerosols of different sizes have different origins and play a different role in the absorption of IR radiation. For example, particles with  $r \leq 0.5 \mu\text{m}$ , making the greatest contribution to the attenuation of radiation in the range  $2\text{--}15 \mu\text{m}$ , consist of mineral substances; organic substances enter into the makeup of fine particles poorly absorbing IR radiation; among the fine particles a considerable fraction consists of soot. The organic substances making up the aerosol are evidently the products of chemical and photochemical reactions in which substances of plant and possibly industrial origin participate. Figures 3, tables 1; references 19: 9 Russian, 10 Western. [62-5303]

UDC 551.510.41:551.510.53:621.375.826

#### INFLUENCE OF INDUCED PHOTOLYSIS OF OZONE ON THE CONCENTRATION OF SMALL STRATOSPHERIC COMPONENTS

Moscow IZVESTIYA AKADEMII NAUK SSSR; FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, 1980 pp 917-923

SIZOVA, I. M. and SUKHORUKOV, A. P., Moscow State University, manuscript submitted 17 July 78

[Abstract] A theoretical study was made of the influence of laser photolysis of ozone on the dynamics of change in the concentrations of the gas components of the stratosphere in laser sounding. The computations were made for radiation intensities at which the local rate of induced decay of ozone exceeds the rate of the restorative reaction of recombination of ozone in the atmosphere. In the dynamics of a number of stratospheric gases a study was made of the role of secondary reactions with the decay products of ozone in dependence on the ozone concentration in the medium and the intensity of UV laser radiation. It is concluded that during the propagation of intensive optical radiation in the stratosphere the presence of a considerable quantity of ozone in the medium exerts a significant influence both on the processes of transmission of radiation through the medium and on the dynamics of concentrations of a number of small air impurities (through the secondary reactions of the products of ozone photolysis). The results clearly indicate the need for taking ozone photolysis into account in the sounding of both ozone and other small impurities in the medium by powerful optical beams and in some cases the need for limiting the energy of lasers in order to reduce side effects. Figures 3, tables 2; references 28: 9 Russian, 19 Western. [62-5303]

## VISIBILITY IN THE CLOUD MEDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 933-938

DROFA, A. S. and USACHEV, A. L., Experimental Meteorology Institute, manuscript submitted 10 Aug 79

[Abstract] A study was made of the optical transmission function of a scattering medium with different radiation scattering phase functions. The optical transmission function is computed in a small-angle approximation and numerically by the Monte Carlo method. The results indicate that in a general case for computing the optical transmission function of cloud media it is necessary to take into account scattering in the entire range of angles ( $0^\circ \leq \theta \leq 180^\circ$ ). In the case of use of the small-angle approximation the error in computing the optical transmission function at all spatial frequencies when making observations in the visible range of wavelengths to optical thicknesses  $\tau \approx 3$  (in the infrared range — to  $\tau \approx 2$ ) does not exceed 20%. In the case of great spatial frequencies the small-angle approximation describes the optical transmission function in the visible infrared range to  $\tau \approx 7$ . Figures 3; references: 14 Russian.  
[62-5303]

## NUMERICAL EXPERIMENT FOR DETERMINING THE PARAMETERS OF ATMOSPHERIC INFRASONIC WAVES BY THE SPECTRAL-COHERENT METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 16, No 9, Sep 80 pp 965-968

GRACHEV, A. I., MATVEYEV, A. K., MORDUKHOVICH, M. I., Institute of Physics of the Atmosphere, manuscript submitted 26 Jun 79

[Abstract] The reception of atmospheric infrasonic waves is accomplished at several spatially separated points, not less than three. Reception usually occurs against a background of noise of turbulent origin comparable in level to the power of signals in this same frequency range. Specialists at the Institute of Physics of the Atmosphere discriminate an infrasonic signal against the background of noise by application of the spectral-coherent analysis method, effective in those cases when there is reception of a signal whose duration is substantially less than the duration of the entire record. This processing method involves computation of the spectral densities of the power of the received signals and spectra and cross spectra carrying information on the phase shifts between signals, smoothing is carried out and the necessary parameters are ascertained. The squares of the coherence spectra and also the frequency variation of the sum of phase shifts (phase spectrum) on three bases are computed, all this assisting in determining the very fact of existence of infrasound against a background of noise and its frequency. The authors describe a model experiment which was carried out for obtaining some idea

concerning the possibilities of determining the characteristics of an infrasonic train of waves against the background of turbulent noise by coherent analysis. Examples of the results of the numerical experiment are presented. Careful attention is given to determination of the relative error in computing the velocity of propagation of the received signal and the error in reckoning the direction of wave arrival, and also the dependence of these parameters on the signal-to-noise ratio. Figures 5; references 6: 4 Russian, 2 Western.  
[62-5303]

UDC 551.508.85

#### ACOUSTIC SOUNDER FOR INVESTIGATING ATMOSPHERIC TURBULENCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKLEANA in Russian Vol 17, No 1, Jan 81 pp 98-102

GERASYUK, N. Ye., KALLISTRATOVA, M. A., KARYUKIN, G. A., MARTVEL', P. E. and NEV-EROVSKIY, K. V., Institute of Atmospheric Physics, manuscript submitted 14 Jan 80

[Abstract] In the Soviet Union the development of acoustic sounding has been inhibited by the lack of powerful specialized electroacoustic converters. There have been only two such sounders in the USSR -- at the Institute of Atmospheric Optics Siberian Department USSR Academy of Sciences and at the Institute of Radioelectronics. These have been put to limited use and have never been employed for a quantitative determination of  $C_T^2$  (temperature fluctuations in a scattering volume). Specialists at the Institute of Physics of the Atmosphere have now developed an expeditionary monostatic acoustic sounder with wind shielding. This article describes the outfit and gives the results of preliminary testing. For sounding to heights of several hundred meters it was found best to use frequencies 1-3 KHz. The fabrication of the sounder was made possible due to the development of a special electroacoustic converter ensuring effective radiation and reception of acoustic waves at a frequency of 2.2 KHz. The various parameters of the apparatus are discussed. A photograph shows the special wind shield erected around the sounder; its design is described. The sounder was tested in the autumn of 1978 near Zvenigorod. The article includes a block diagram. The first results of  $C_T^2$  measurements are given. Figures 4; references 17: 10 Russian, 7 Western.  
[86-5303]

## INFLUENCE OF STRATOSPHERIC AEROSOL ON THE ASCENDING FLUX OF SCATTERED SHORT-WAVE RADIATION

Leningrad TRUDY GLAVNOY GEOFIZICHESKOY OBSERVATORII: DINAMIKA GLOBAL'NYKH ATMOSFERNYKH PROTSESSOV I PROGNOZ POGODY in Russian No 410, 1980 pp 96-102

DMITRIYEVA, L. R. and CORBUNOVA, T. N.

[Abstract] The problem of stratospheric aerosol is of great importance for investigating factors determining recent climatic changes. A number of studies have used a model of transfer of short-wave radiation in a cloudless plane-parallel atmosphere, taking into account molecular and aerosol scattering, and also molecular and aerosol absorption. These studies have shown that the influence of stratospheric aerosol on the ascending flux of short-wave radiation is dependent on the true solar angle and on the albedo of the underlying surface, on the refraction coefficient, optical thickness of scattering and absorption. However, these studies have been characterized by extremely great detail and unwieldiness of the computations involved. Other studies, based on the monochromatic method, are sufficiently simple with respect to the computations, but cannot be considered reliable for characterizing the integral fluxes. The authors have therefore attempted to evaluate the influence of stratospheric aerosol on the fluxes of ascending short-wave radiation and albedo of the system using a method which is intermediate, a compromise between the methods suggested by other authors. The computations are based on the method for solution of the transfer equation in a two-flux approximation. An example is cited. The profiles of the fluxes of scattered radiation, computed with allowance for only surface aerosol and with allowance for both surface and stratospheric aerosol, indicate that the differences in the fluxes are rather significant. The layer of stratospheric aerosol sharply changes the vertical profile of the ascending flux. This fact is highly dependent on the albedo of the underlying surface. The change in the solar zenith angle exerts an influence on the ascending flux. A table compiled by the authors shows that this stratospheric layer of aerosol can increase the ascending scattered flux of short-wave radiation by a factor of 1.5-2. This can exert a substantial influence on the radiation energy of the atmosphere. Figures 2, tables 1; references 9: 6 Russian, 3 Western. [107-5303]

UDC 551.524.1:551.551.2

## INVESTIGATION OF MICROSTRUCTURE OF THE TEMPERATURE FIELD USING OPTICAL MEASUREMENTS IN THE ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 2, Feb 81 pp 160-166

TIME, N. S., Institute of Physics of the Atmosphere, USSR Academy of Sciences, manuscript submitted 25 Oct 79, resubmitted after revision 21 Apr 80

[Abstract] The correlation between the frequency spectrum of fluctuations of the amplitude  $\chi$  of a light wave passing through a turbulent medium and the parameters of this medium makes it possible to obtain information on the spectrum of the

field of the refractive index in the optical range, and accordingly, on the spectrum of the temperature field. In order to apply this possibility the author carried out measurements of  $\chi$  on an atmospheric path with a length of 40 m at a height of 1.2 m above a level sector of the steppe in the neighborhood of Tsirlyansk. At the same time microfluctuation measurements were made of the wind velocity at this same height near the path. The results of the measurements were used in computing the  $\chi$  spectra. The integral equation relating the  $\chi$  spectra and the temperature field was solved by the statistical regularization method. A solution was found in the form of a correction to the power-law spectrum of temperature. The determination of the rate of dissipation of the kinetic energy of turbulence from thermoanemometric measurements made it possible to represent the spectrum in dimensionless form and compute the value of the universal constant  $C_\theta$  from the "2/3" law for the structural function of the temperature field. The results are compared with data from microfluctuation measurements of temperature in the air carried out by other authors. Figures 4; references 18: 5 Russian, 13 Western.

[118-5303]



## ARCTIC AND ANTARCTIC RESEARCH

### REGULAR FLIGHTS FROM MOSCOW TO ANTARCTICA DISCUSSED

Leningrad LENINGRADSKAYA PRAVDA in Russian 10 Feb 81 p 2

[Interview with Deputy Director of the Arctic and Antarctic Scientific Research Institute (for Antarctica) Ye. S. Korotkevich, doctor of geographical sciences, in Leningrad, by V. Volkov]

[Text] In February of last year the Aeroflot aircraft IL-18D (long-range) number 74267, leaving Moscow, covering some 16,000 km, blazed the shortest route to the sixth continent. The landing was made not far from the "capital" of the Soviet Antarctic researchers -- the meteorological center at Molodeshnaya. There, near Vechernyaya Mountain, an unprecedented snow-ice airport has been constructed. It was constructed for the first time in world practice by specialists of the institute "Len-aeroprojekt" in cooperation with the workers of the Arctic and Antarctic Scientific Research Institute.

This was a "technical" flight, that is, a trial. And now preparations are being completed for a scheduled flight to distant Enderby Land. The red-winged airliner so familiar to us will proceed to the execution of passenger flights on this transcontinental route. It will deliver 40 winterers to Antarctica and on the way back will take aboard those whose time has come after long work on the severe continent.

Our correspondent V. Volkov converses with the Deputy Director of the Arctic and Antarctic Scientific Research Institute for Antarctica, Doctor of Geographical Sciences Ye. S. Korotkevich, concerning the impending air expedition.

[Question] Yevgeniy Sergeyevich, the route has been tested, and accordingly remains unchanged?

[Answer] There have been changes. Whereas last year the aircraft headed from Moscow immediately to the south, now it will first proceed northward -- to us at Leningrad. This is easy to understand. Our institute is the center of Soviet polar research. The Antarctic Expedition, forming the seasonal and wintering parties of polar specialists and coordinating their work on the sixth continent, is situated in Leningrad. As a rule ships with cargo and people depart from Leningrad for the most southerly continent. Now aircraft have laid out a route to Antarctica from the city on the Neva. After taking on passengers at Pulkovo, the IL aircraft will fly to Odessa. Then the usual route will be taken: Cairo-Aden-Naputo-Molodeshnaya. The distance, including from Moscow to Leningrad, is 17,190 km. The airmen plan to overcome this distance in 30 hours flight time.

And still another detail: the last time the scientific research ship "Professor Vinnik" was situated on the most difficult segment — the route across the ocean with a length of 5,000 km. It served as a radio beacon and relay station for the aircraft on the route to Enderby Land. This time it was decided to get by without the assistance of the ship. The radio center Molodetskaya was completely able to handle this.

[Question] So this means that there is full basis for saying that regular air communication is beginning with Soviet Antarctic stations?

[Answer] To be sure, aircraft will not be going there every day and not even every month, but for the time being only twice a year. But we do not now need more service. The next flight is planned for November, the last month of the Antarctic spring. When the ice has not yet retreated and ships cannot approach the continent. But the weather already enables geologists and biologists, for example, to proceed to their research. And an aircraft will deliver these specialists much sooner than the first ship will arrive.

In the future we plan to use the IL-18 for transport work on the continent itself. In particular, for the transport of freight from Molodetskaya to other stations and especially to the intracontinental station Vostok. Fuel and foodstuffs for the time being are delivered there by sledge-tractor trains from Mirnyy Observatory: 1,410 km of severe snow desert. The next airdrome will therefore evidently be created at Vostok. It is an attractive idea to use this aircraft for investigations of the continent. During the flight to the South Pole last year it already served as a scientific laboratory for geophysicists and meteorologists. Therefore, in the future we plan to carry out more extensive scientific research from aboard the plane in the regions of difficult access. That is, the IL-18 will soon be working fully the entire summer season. But with approach of the Antarctic autumn it will return home, to the motherland.

[Question] Who is entrusted with piloting the airliner?

[Answer] From Moscow to Leningrad the plane will be piloted by Anatoliy Nikolayevich Denisov, who on the trial flight had been ship commander. He will also fly it to Aden. Denisov is not flying to Antarctica this time. Anatoliy Nikolayevich has undergone retraining and will soon take under his command a TU-154, which will service the northern lines in our country. As far as Aden, as before, the IL will be flown by a crew headed by Yevgeniy Petrovich Bunchin. There the command will be taken over by Viktor Vasil'yevich Bushuyev, who on the trial flight had been the co-pilot. The remaining members of the Antarctic crew are the same.

The commander of the Vostok flight subdivision Mikhail Mikhailovich Niroshnichenko has been designated head of the aviators. The flight director is Boris Andreyevich Krut'skiy, Deputy Director of the Arctic and Antarctic Scientific Research Institute.

[Question] What is the condition of the snow-ice airdrome?

[Answer] The landing strip, although not inferior to a concrete strip, as indicated by the trial flight, nevertheless is dependent on the state of the weather. Above-zero temperatures are no good. But at Molodeshnaya the weather at the present time, to speak outright, is like that in Leningrad. Somewhat below zero, during the 24-hour period averaging  $-3^{\circ}$ . That is what is required. The airdrome service has tested the strip with a special platform with a 70-ton weight mounted on the chassis of an IL-18 aircraft. The depth of penetration of the wheels over the entire area of the landing strip was in the limits of one centimeter. And the admissible depth is six centimeters. An emergency airdrome has been prepared at Novolazarevskaya. Molodeshnaya regularly gives the aviators a timely weather forecast and reports on what wind direction and velocity can be expected at a height of 6-10 km along the route Naputo-Molodeshnaya.

In short, at the polar capital they are awaiting the first passenger liner and are ready for its reception.

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...Yesterday the IL-18U made a landing at Pulkovo. Refueling, the last investigation was made of the navigation instruments and engines before the highly important flight. Today at midday the red-winged airliner will take off for the ice continent. [146-5303]

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CSO: 1829

## 26th EXPEDITION HEADS FOR ANTARCTICA

Riga SOVETSKAYA LATVIYA in Russian 25 Jan 81 p 4

[Article by I. Geyman]

[Summary] The steamer "Estoniya" yesterday departed from the wharf of the Riga Marine Passenger Station. It is heading for the shores of Antarctica carrying 90 scientists of the Antarctic Expedition. On its way back the ship will bring home 300 participants of the 25th Soviet Antarctic Expedition. This is the eighth Antarctic expedition for the "Estoniya," including each of the last five years. Each such voyage takes three months and the distance covered is 24,500 nautical miles. The route taken is to the Canary Islands and then to Montevideo. Work in the Antarctic area will last a month, with the ship visiting the scientific stations Bellingshausen, Molodezhnaya, Druzhnaya and Mirnyy. The ship will deliver equipment, tools, food and very heavy engines for tractors. The unloading of this difficult cargo will have to take place in the open sea. The shipboard winches are too weak for this purpose and cargo will have to be removed by helicopter. En route the ship passes through a zone of iceberg danger -- beginning at the 50th parallel. Iceberg fragments are especially treacherous: they are transparent, invisible and cannot be picked up on radar. Their upper parts measure 2-3 meters in diameter, but the underwater part is 7-8 times greater. These constitute a great danger for the ship's hull. Searchlights must be mounted on the deck and four men must constantly keep watch. Autumn is now setting in near the shores of Antarctica; there is less ice but more icebergs. The conditions are favorable for an ordinary ship, rather than an icebreaker. At the shores of Antarctica all the work is done from small boats because the "Estoniya" does not tie up to the shore ice. The "Estoniya" is a very comfortable passenger ship. It is usually a cruise ship transporting Soviet and foreign tourists.

[96-5303]

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#### BRIEFS

26th ANTARCTIC EXPEDITION--The arrival of winter on the icy continent is being marked by the handing over by the head of the 25th Soviet Expedition N. Tyabinyy of the symbolic "keys" for the Soviet south-polar stations to the leader of the new winter 26th Soviet Antarctic Expedition V. Shamon'yev. The seasonal base "Drushnaya," on the banks of the Weddell Sea, has been closed until next year. Here members of the geology-geophysical detachment carried out a large work program successfully. Two sledge-tractor trains returned from treks into the icy reaches of Antarctica. [Excerpts] [Moscow IZVESTIYA in Russian 22 Mar 81 p 6] [116-P]

OPENING OF NEW ARCTIC STATION--The new scientific research drifting station "Severnnyy Polyus" -- No 25 -- will be established on the ice of the Central Arctic. Its organization has been entrusted to members of the aerial high-latitude expedition "Sever-33," which departed from Leningrad today. The search for suitable ice floes sufficiently large and solid or icebergs which are sufficiently flat will be carried out in the eastern sector of the Arctic north of Wrangel Island. The scientists and specialists will also carry out another broad program: they will make landings on the ice in more than 150 places in the ocean, including the geographic north pole. They will conduct comprehensive observations of the water medium, atmospheric processes and the status of arctic ice. The expedition will also carry out a crew exchange on the drifting scientific station "Severnnyy Polyus-22." [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 19 Feb 81 p 2] [102-P]



## EXPERIENCE IN WINTER USE OF A RADIONAVIGATIONAL SYSTEM

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 12, Dec 80 pp 26-29

YELISEYEV, B. V., GRIGOR'YEV, V. I. and KHARITONOV, V. S.

[Abstract] The use of radionavigation systems during winter has a number of peculiarities. After reviewing the literature, the authors describe their experiments in some detail. It was found that radionavigational systems operating in the range 1.5-2 MHz can be used successfully in winter for determining the coordinates of objects when carrying out different types of surveys. An underlying surface in the form of sea ice exerts a substantial influence on the velocity of propagation of radio waves in the range 2 MHz. The results of processing of the collected data indicated that in a specific region with an ice thickness of 1.5-2 m the velocity of propagation of radio waves is approximately 298 400 km/sec. In the case of determination of the actual velocity of propagation of radio waves in the working zone of radionavigational systems operating at frequencies of 1.5-2 MHz it is possible to ensure the required accuracy of surveys at scales of 1:10 000-1:25 000. The collected actual data agree relatively well with the results of theoretical computations. However, the rapid change in velocity of propagation of radio waves does not occur in the segment of the path extending from the station to 5-10 km, but near it (at distances up to 1000-1500 m). Then the velocity becomes approximately constant for the entire working zone of the system. Figures 1, tables 2; references 2: 1 Russian, 1 Western.

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